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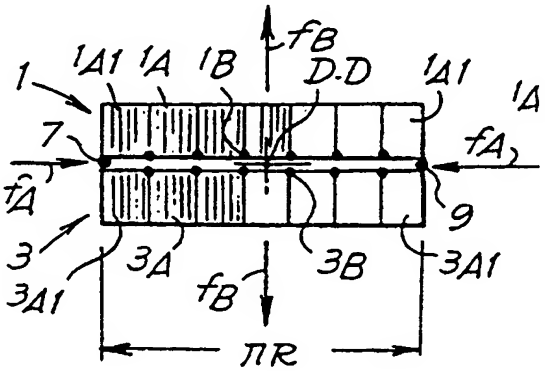

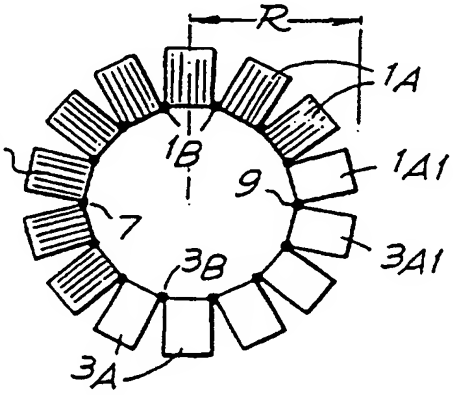

(57) Abstract

The knitting machine for the production of tubular articles with one end closed comprises needle plate sections (1A1, 1A; 3A1, 3A) hinged together (at 1B, 3B) and movable to assume a configuration with two opposing and substantially rectilinear needle plates (1, 3) (Fig. 1) to obtain, by the interaction between the needles of the opposing needle plates, the initial closure of the tubular article, and a configuration with a substantially circular needle plate (Fig. 2); substantially stationary textile mechanisms, interacting with the needle plates in the said configurations, are provided.

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Description

Process and machine for knitting tubular articles with one end closed, with needle plates having a modified configuration

Technical Field

The invention relates to an improved process and machine for knitting tubular articles with one end closed, such as pantihoses, socks and similar articles.

Background art

According to the present technique, pantihoses are normally produced by firstly knitting two tubular leg portions, and subsequently by connecting said leg portions together, in order to form a complete knitted article of manufacture, including two leg portions and a body portion.

From US Pat. N. 5.226.297 a knitting machine is known, which is able to produce a complete pantihose, without the need of subsequent sewing of two leg portions together.

This known machine performs the whole knitting process by means of rectilinear needle fronts.

The principal object of the invention is to carry out a preponderant part of the knitting in the characteristic conditions of knitting with circular needle plates and particularly with cylindrical needle plates, and consequently with regularity of knitting, high operating speeds and limited inertia. These and other objects and advantages will be made clear in the following text.

The principles of the present invention are also applicable to machines of the type claimed in preceding patents held by the present holder.

Disclosure of the Invention

Substantially, the process is such that a tubular knitted article with one end closed, by means of knitting needles, according to the invention is - starting from the initial closed end - initially worked with a substantially

rectilinear configuration of the needles on two opposing beds (plates), and that the subsequent tubular working is carried out with the needles in one bed in a substantially circular configuration. In each of the configurations, working is in practice carried out by rotation of the needle assembly with respect to the textile mechanisms - needle and under-needle operating selectors, thread guides and others - which are kept in substantially stationary conditions and in rigidly fixed conditions when the configuration of the needles is circular.

A knitting machine for the production of tubular articles with one end closed substantially comprises needle plate sections which are movable to assume a configuration with two opposing and substantially rectilinear needle plates to obtain, by the interaction between the needles of the opposing needle plates, the initial closing of the tubular article, and a configuration with a substantially circular needle plate; substantially stationary textile mechanisms, interacting with the needle plates in the said configurations, being provided.

A machine of this type may comprise: a moving element capable of rotating about its own axis; on the said moving element, two symmetrical upwardly converging needle plates extending orthogonally to the axis of rotation, for the formation of a tubular article with one end closed; along and around the said two needle plates, guide means for a section of chain carrying textile components - including cams, selectors and thread guides - capable of interacting with the needles and the under-needles of the said two needle plates; means of rotating the moving element for knitting; and means of holding the chain section in a position which is stationary on average with respect to the rotating needle plates. In the said machine, each needle plate may consist of a plurality of needle plate sections, each having grooves for a certain number of needles, the said needle

plate sections being possibly interconnected in a hinged way; and means may be provided to change the configuration of each needle plate from a substantially rectilinear one with opposing needle plates to a curved one, to form a circular cylindrical needle plate, and vice versa.

A machine of this type may also comprise two adjacent moving elements capable of operating independently with a variation of configuration of the needle plates between rectilinear and circular; and means of combining the needle plates of the said two moving elements for working a single tubular article as a continuation of the tubular articles produced by the needle plates of the two moving elements. The needle plates of the two moving elements may be made to form two extended needle plates capable of assuming a semi-circumferential configuration, the outer ends of the outer sections of the needle plates butted against each other being kept adjacent and the inner ends separated to form this semi-circumferential configuration of the extended needle plates.

Other characteristics of the invention are specified in dependent claims at the end of the present description.

Brief description of the Drawings

The invention will be more clearly understood from the description and the attached drawing which shows a non-restrictive practical example of the invention. In the drawing,

Figs. 1, 2 and 3 show a first outline of a solution in the configuration with a rectilinear double needle plate and transformed into a circular configuration, and an enlarged detail of Fig. 2;

Figs. 4 and 5 show a second outline of a solution in the configuration with two rectilinear double needle plates and transformed into circular configurations;

Figs. 6, 7 and 8 show a third outline of a solution, in the configuration with two rectilinear double

needle plates (capable of transformation into circular configurations as shown in Fig. 5), with an extended rectilinear double needle plate, and in a single circular configuration;

Figs. 9, 10 and 11 show three stages of working of an article in the form of tights (pantihose);

Figs. 12, 13, 14 and 15 show a fourth outline of a solution, in four different successive configurations;

Figs. 16, 17 and 18 show an overall view of a machine in two orthogonal vertical sections, in the configuration with rectilinear and opposing needle plates, and an enlarged detail of Fig. 17;

Figs. 19 and 20 show a detail on a larger scale than Figs. 16 and 17, illustrating the configuration with circular needle plates;

Figs. 21 and 22 show, similarly to Figs. 16 and 17, the configuration with a single circular needle plate;

Figs. 23 and 24 show the rectilinear configuration of the separated double needle plates in plan and in section through XXIV-XXIV in Fig. 23, enlarged;

Figs. 25, 25A, 26 and 27 show the circular configuration of the separated needle plates, in plan, an enlarged detail of Fig. 25, and in sections through XXVI-XXVI and XXVII-XXVII in Fig. 25;

Figs. 28, 29 and 30 show the rectilinear configuration of the extended double needle plates, in plan and in sections through XXIX-XXIX and XXX-XXX in Fig. 28;

Figs. 31 and 32 show the circular configuration of the joined needle plates, in plan and in section through XXXII-XXXII in Fig. 31;

Fig. 33 is a plan diagram of operating systems for the symmetrical movement of the two moving elements, and operating systems for pantograph members;

Figs. 34 to 37 are plan views of the operating systems for pantograph members and various configurations of them in association with the chains engaged with them,

and sectors for locking these chains in the circular needle plate configuration;

Fig. 38 shows an enlarged detail of Fig. 22;

Fig. 39 shows an enlarged detail of Fig. 38;

Figs. 40, 41 and 42 show in three views, with parts in section, a slide with a segment of intermediate needle plate;

Figs. 43 and 44 show two devices with calliper levers to provide or facilitate the change in configuration between rectilinear and circular;

Figs. 45, 46, 47 and 48 are functional diagrams to illustrate successive positions taken up by appendages of profiled guiding bodies of end sections of needle plates;

Figs. 49, 50, 51 and 52 show three possible configurations of a possible embodiment of the sections of needle plates, and a modified embodiment;

Fig. 53 shows a perspective detail of a part indicated by the arrow fLII in Fig. 40;

Figs. 54 to 58 show in plan, in sections through LV-LV and LVI-LVI in Fig. 54, and in enlarged local transverse sections through LVII-LVII and LVIII-LVIII in Fig. 54, devices for moving appendages of outer ends of the needle plates and devices for assisting in the change of configuration of the needle plates;

Fig. 59 shows in section a detail of a locking device, indicated by the arrow fLIX in Fig. 55, in various configurations of its members;

Figs. 60, 61 and 62 are three partial plan views of members of a machine with a chain made from a flexible strip, in the configurations corresponding to rectilinear needle plates;

Fig. 63 is a transverse section through LXIII-LXIII in Fig. 61;

Fig. 64 is a transverse section approximately through LXIV-LXIV in Fig. 63;

Fig. 65 shows separately, and on an enlarged scale, guide members of the strip chain;

Figs. 66, 67 and 68 show three plan views similar to those in Figs. 60, 61 and 62, in the configurations corresponding to circular needle plates, Fig. 68 being enlarged and partial; and

Fig. 69 shows a further variant embodiment in vertical transverse section.

Best Mode for Carrying out the Invention

Figs. 1 and 2 show an outline of the transformation of the configurations of a machine from rectilinear to circular. The numbers 1 and 3 indicate two needle plates consisting of series of sections of needle plate 1A and 3A, each of which comprises a plurality of grooves 5, indicated in the detail in Fig. 3 which illustrates some of the sections 1A; the sections 1A are hinged together as indicated at 1B at the edge from which the needles, which can slide in the grooves 5, project for the formation of the knitted fabric; the sections 3A are hinged together at 3B in the same way. The end sections 1A1 and 3A1 are hinged together as indicated schematically at 7 and 9. The sections 1A and 3A can be aligned with each other to form a rectilinear double needle plate as shown in Fig. 1, and can have their configuration changed with a movement of the hinges 7 and 9 in the direction of the arrows fA so that they approach each other, while in the central area of the rectilinear needle plates shown in Fig. 1 the arrows fB indicate the movement of the sections of the central area, for the separation from each other of their hinges 1B and 3B and for the formation of a substantially circular configuration of the inner edges of the sections of needle plates, and consequently for the substantial formation of virtually circular needle plates. The reverse movement returns from the configuration in Fig. 2 to the configuration in Fig. 1.

This concept may be applied in a machine which is designed for the production of a tubular article, for example a sock or a leg of a pair of tights or pantihose, which requires the closure of one end; the closure is

executed by interaction of the needles of the two needle plates formed by the sections 1A and 3A in the rectilinear configuration, in a conventional way, while the body of the tubular fabric may be produced in the approximately circular configuration shown in Fig. 2, with the advantages of a configuration of this type with respect to the rectilinear configuration. According to the specifications of other preceding patents cited above, the working may be executed with the rotation of the needle plate assembly - in both the rectilinear and the circular configurations - about the axis D-D with respect to the textile mechanisms which are kept substantially stationary, or, at least in theory, in the opposite conditions, namely with fixed needle plates and textile mechanisms rotating or otherwise moving about them.

The same principle may be applied in machines designed - in a similar way to the specifications of other preceding patents such as those mentioned above - to produce complete articles of the type known as tights or pantihose, with the complete working of the article on the same machine. Figs. 4 to 8 show in a highly schematic way the possibility of having two moving elements which can be transformed from rectilinear double needle plates 1X, 3X and 1Y, 3Y, as shown in Fig. 4 (and in a similar way to what is illustrated in Fig. 1) into the configuration with circular needle plates as shown in Fig. 5 (and correspondingly illustrated in Fig. 2) and to return the needle plates again from the circular configuration to the configuration with double needle plates rectilinear and aligned as shown in Fig. 6. The double needle plates can rotate about axes K-K, in the direction of the arrows in Figs. 4 and 5. The needle plates 1X, 3X and 1Y, 3Y are then made to approach each other (after alignment with each other) in the direction of the arrows fC in Fig. 6, to be joined to each other directly or with the interposition of further intermediate segments of needle plate (to form a seam in the area of the crutch) as

indicated by 10 in Fig. 6, these segments being made to approach each other as indicated by the arrows fE, so that they are interposed between the two double needle plates which are joined in the direction of the arrows fC, and are aligned with them. This produces the configuration shown in Fig. 7, in which the double needle plates 1X, 3X, 1Y, 3Y, with the interposition of intermediate segments of needle plate 10 if necessary, form an extended rectilinear double needle plate with which a partial and temporary working may be executed; the configuration of the sections of needle plate may then be changed from the configuration shown in Fig. 7 to the configuration shown in Fig. 8 with the joining of the outer hinges 7 in the direction of the arrows fF and the separation of the central areas - including any intermediate segments of needle plate 10 - in the direction of the arrows fG, and then with the splitting and mutual separation of the hinges 9 joined to any needle plate segments 10. In this way a new overall circular configuration of the needle plate sections of the four groups is obtained for further working. Each of the two needle plate assemblies shown in Figs. 4 and 5 can rotate about its central axis K-K in the direction of the arrows in Figs. 4 and 5; after the joining, as shown by a comparison of Figs. 6 and 7, there may be a rotation in the direction of fH about a central axis H-H with respect to the extended needle plates, and a rotation in the direction of the arrow fL shown in Fig. 8.

A machine as schematically illustrated in Figs. 1, 2 and 3 may be used for the formation of tubular articles, for example the legs of socks or tights or other articles as shown at G in Fig. 9, the tubular working being executed principally in the circular configuration shown in Fig. 2 or shown in Fig. 5, while the closure of an initial end, for example the toes of the legs, as indicated by CG in Fig. 9, is executed in the rectilinear configuration shown in Fig. 1 and in Fig. 4 with interaction of the needles of the two opposing needle

plates, according to the known art.

In a machine as shown schematically in Figs. 4 to 8, it is possible to work a pair of tights or pantihose with the working of the toes CG (as mentioned previously with reference to Fig. 9) and continuing the working as shown in Figs. 10 and 11, working the legs G in the conditions shown in Fig. 5 of two circular rotating needle plates, while at the start of the crutch area, in other words at the start of the body or corset CP, the configuration is changed as shown by a comparison between Figs. 5, 6 and 7 to form, in the central area of the extended rectilinear needle plates - for example in the area of the said needle plates consisting of the intermediate needle plate segments 10 inserted in the intermediate position - a crutch seam line as indicated by CC, which is transverse with respect to the article as worn, and with continuation of the legs with the areas corresponding to the needle plate sections 1X, 3X and 1Y, 3Y which have worked as shown in Figs. 4 and 5 but in the rectilinear configuration as shown in Fig. 7; the working of the body CP is continued in the circular configuration shown in Fig. 8 with all the needle plate sections arranged in a circular condition, up to the formation of the final hem which may be an elastic hem as shown by BE in Fig. 11, worked in a conventional way as in circular machines for the release, and then until a return is made to the conditions in Fig. 4 to operate with a series of subsequent cycles. The transformation of the needle plates from rectilinear to circular takes place after the formation of a sufficient quantity of fabric, starting from the seam lines CG and CC.

Figs. 12 to 15 show functional diagrams of a variant embodiment in the phases corresponding to those in Figs. 4, 5, 7 and 8; equivalent mechanisms are indicated by the same references with the addition of "1000". In this solution, the intermediate needle plate segments 1010 have a needle face width greater than that of the segments

10 and the double needle plates 1001X, 1003X and 1001Y, 1003Y are not made to approach each other in the direction of fC (and the axes K-K are stationary). This is a simplification, provided that the dimensions of the intermediate segments 1010 are sufficiently great, to match the overall dimensions of the elements connected to the two double needle plates 1001X, 1003X and 1001Y, 1003Y during the rotations about their respective axes K-K. To ensure correct matching in the circular needle plate configuration, each intermediate segment 1010 may be in two portions, having dimensions corresponding to the sections 10 or equivalent, and movable angularly. To avoid interference it is possible, in this disposition, to provide rotation of the said double needle plates 1001X, 1003X and 1001Y, 1003Y about the respective axes K-K, which are always synchronized but with an angular phase displacement of the needle plates to avoid instantaneous conditions of alignment during rotation, alignment being provided only at the start and end of the said rotations.

Structures of a flexible machine to obtain the transformation of the needle plates from rectilinear to circular, by the principle described above, will now be described in greater detail.

In a first embodiment (Figs. 16 to 59) the number 21 indicates a fixed frame which has an upper base table 23 (Figs. 16, 17). On this base table there is engaged rotatably a platform 25 which can be made to rotate by the engagement of a ring gear of the said platform 25 with a pinion 27 of a motor 29 which is used to drive the platform in rotation during the working of the body. On the platform 25, which remains fixed during the working of the legs, there are provided sliding and rotation supports for two moving elements designed to be powered during the formation of the legs, these moving elements being capable of separation from and approach to each other. Each of these two moving elements comprises in particular, and schematically, a shaft 31 pierced axially to form a

pneumatic suction duct for the tensioning of the article being formed and an upper shelf 33. Each moving element 31, 33 may be driven for example by its own electric motor 37, which may also be coupled directly to, and therefore coaxially with, the corresponding tubular shaft 31. Sections of needle plate which are to create the rectilinear and circular needle plates according to the principles mentioned previously can move on the flat upper surface of the table or plate 33 of each of the two moving elements.

The two moving elements 31, 33 may be operated so that they slide together or apart, by means of an actuator with opposite threads 38 and motor 39 (Figs. 16, 17, 21, 22, 33). This movement is avoided in certain cases.

The number 41 indicates profiled bodies combined with corresponding needle plate sections indicated by 43, corresponding to profiled bodies 41I and needle plate sections 43I to be described subsequently. Each of the profiled bodies 41 has a prismatic shape, so that a plurality of such profiled bodies 41 may be disposed in a line to align corresponding needle plate sections carried by them to form rectilinear needle plates. The profiled bodies 41, whose corresponding needle plate sections 43 are to be aligned to form a needle plate, are connected together on the inner front surface 41A by a flexible strip 45, normally made of metal resistant to fatigue over a long period, so that these front surfaces 41A and the strip 45 form hinges 45A which are vertical or in other words perpendicular to the sliding surfaces of the tables 43, the axes of these hinges 45A being located at the upper ends of the needle plate sections 43, in the area of operation of the needles which are made to project from the needle plates, these needle plates being formed by the needle plate sections 43 which are slightly inclined towards each other and upwards in the configuration of rectilinear double needle plates, as shown in Figs. 16, 17, 18 and 23. Consequently each of the two moving

elements 31, 33 has two groups of profiled bodies 41 and therefore two groups of needle plate sections 43, which are connected together by the hinges formed by the strip 45 in the bending areas 45A.

Each of the profiled bodies 41 has (Figs. 18, 19, 30) two adjacent pins 47 for two links 49, which engage with each other by means of toothed sectors 49A which permit and ensure equal and symmetrical movement of the two links engaged with the two pins 47 of each profiled body 41. The links 49 are hinged together in pairs with hinges 52, each of which connects externally in calliper form two contiguous links 49 hinged to contiguous profiled bodies 41. In each group of profiled bodies 41 and hinged needle plate sections 43, a pair of special links 49B and 49C is provided in an intermediate position and is hinged to a hinge 52A and powered by a motor actuator 54 which is integral with one of the special links - in particular, for example, with 49B - and which drives through a transmission 56 the other of the special links 49C; the actuator 54 therefore causes the angular separation and approach of the two special links 49B, 49C; owing to the chaining between the various links 49 as indicated through the toothed sectors 49A and the hinges 52, the operation of the motor actuator 54 causes all the pairs of links to take up the same angular formation which is set by the actuator with the two special links 49B and 49C. Since the assembly of links 49 is hinged to the pins 47, a change in their reciprocal angular configuration causes a change in the reciprocal angular configuration between the profiled bodies 41 and consequently between the corresponding needle plate sections 43. Essentially, the motorized actuator 54 may cause the change of configuration of the needle plate sections 43 from the rectilinear to a curved configuration, until an approximately semicircular form is reached, either in a broken line or with arcs as indicated below. The operation of the motorized actuator 54 may itself cause the changes of configuration of a group of

needle plate sections hinged together with a flexible metallic strip 45. The two groups of sections belonging to a single moving element and then combined with a single table 33 have to have their configuration changed in a completely symmetrical way, and furthermore the end needle plate sections indicated by 43X and 43Y have to remain with their end angles brought together to ensure the integrity of the article being formed during the transformation from the rectilinear configuration of the facing needle plates to the curved configuration, as indicated in the explanation of the principle relating to Figs. 1 to 8, in which it is pointed out that the hinges 7 and 9 must be kept next to each other in the change of configuration of the needle plate sections from rectilinear to curved. For this purpose, the profiled bodies 41 of the outer needle plate sections 43X have (see in particular Figs. 23, 28, 43, 44-48, 54) appendages 60, each of which has a partial cylindrical surface housed in a corresponding semi-cylindrical socket 62A of one of the two opposing sliding block jaws 62; the said jaws are slidable in dovetailed guides which are transverse with respect to the arrow fA on a slide 64 which can slide in guides 66 formed in the table 33. The two jaws 62 are made to separate, and they are forced to approach each other while sliding in the direction of the arrow fA, in other words towards the centre of the rectilinear needle plates, for example by the action of cam profiles 68 which converge in the direction of the arrow fA, these profiles 68 acting on the jaws 62 against the action of the springs 62B which tend to separate them. The slide 64 can be moved in the direction indicated by the arrow fA, and in the two directions of the arrow and opposite to the arrow by means of an actuator, for example a motor 70 which rotates a screw 72 engaged with a female screw on the slide 64. At the opposite ends of the needle plate groups, in other words at the positions of the needle plate sections 43Y, each of the corresponding profiled bodies 41 also has a

lower appendage 76 similar to 60, also in the form of a sector of a cylinder; the two appendages 76 are next to a V-shaped guide 78 formed like the guide 66 in the table 33, in alignment with the guide 66 and converging to an end 78A with a cylindrical wall, having a curvature corresponding to that of the appendages 76.

With the disposition described above it is possible to obtain a change of configuration of the needle plate sections 43 and consequently of the corresponding profiled bodies 41 from rectilinear to curved, with movements of the angles of the end profiled bodies 41X and 41Y and of the end needle plate sections 43X and 43Y by means of the appendages 60 and 76. In particular, the operation of the motor actuators 54 and consequently of the series of calliper links 49, 49B and 49C causes the said needle plate sections to curve out of the rectilinear configuration, the operation of the actuators 54 being made simultaneous with the operation of the actuator 70 which moves the slide 64 and consequently the jaws 62 in the direction of the arrow fA, thus causing the joining of the appendages 60 as a result of the approach of the jaws 62 along the profiles 68 until the appendages 60 are joined at the position 60X. Correspondingly, the same hinges of the calliper links 49 cause the appendages 76 to move within the V-shaped guide 78 to the end 78A of the guide, where the appendages 76 are housed in a condition 76X substantially symmetrical to 60X, and in a position centred by the joining of the appendages 76 with their cylindrical surfaces in the end 78A of the guide 78. The operation of the actuators 54 and 70 therefore causes the transformation from the rectilinear configuration to the semi-cylindrical configuration, in conditions of perfect symmetry of the two needle plate section groups relating to each of the two moving elements 30, 33.

With the disposition described, it is therefore possible to start the working of two tubular articles with the closure (such as the two toes CG of two legs) with the

two rotating moving elements having the needle plates rectilinear for the formation of the closure CG. After the said transverse seam has been formed along the sections CG at the toes, the initial formation of the article with the toes and legs is started, with the needle plates kept in a rectilinear configuration, until a sufficient quantity of fabric is available between the seam CG and the working area of the legs G being formed. When this first part of the working of the legs has been completed, the configuration of the rectilinear needle plates can be changed to a circular configuration with the needle plate sections, to form a substantially circular needle plate on each of the moving elements 31, 33 (Figs. 19, 20, 25). The transformation has to take place with a temporary interruption of the working of the legs G to move the needle plates from the rectilinear configuration to the cylindrical configuration by the method stated above. The working then takes place in practice as in a circular machine. The cylindrical configuration for the working of an article such as the leg is provided by fixing the profiled bodies 41 and the needle plate sections 43 on the tables 33 by means of pin-type locking systems indicated in a general way by 80, which can be raised and expanded to lock the profiled bodies 41 in the various positions which they have to assume in the rectilinear and curved configurations; these locking systems 80 are therefore present in sufficient numbers and are disposed in the most suitable way to obtain the locking of the profiled bodies 41 in the three configurations, and are made to come into operation at the correct time and selectively by a suitably programmed system, these systems 80 generally being pneumatically or hydraulically operated. The pin locking systems 80 may, for example, comprise (see Fig. 59) a first cylinder-and-piston operating system 81A, 81B to lower an elastic pin 83 with a number of slits, which is integral with the piston 81B and can be raised into a socket 85 formed in the body 41, this socket being aligned

with the elastic pin 83 (which will be suitably bevelled for entry); the pin can be raised by a spring 84, which opposes the pneumatic action of the operating system 81A, 81B. The elastic pin 83 can be expanded at the correct time inside the socket 85 of the truncated conical head 86C of the piston 86B of a cylinder-and-piston operating system 86A, 86B which tends to raise the head 86C against the action of a spring 87; this spring 87 tends to wedge the head 86C and expand the raised pin 83, locking it in the socket 85 in the profiled supporting body 41, in order to secure it to immobilize the corresponding needle plate section 43 on the moving element 31, 33 (and also to lock the needle plates in the configuration for formation of the body, in a subsequent phase to be described below).

Each of the profiled bodies 41 has (Figs. 24, 39 and others) a pair of grooved rollers 90 with a vertical axis and an outer wall 41Z, to form the guide for carriage links 92 hinged together to form sections of chain designed to support the textile mechanisms designed to interact with the needle plates formed by the needle plate sections 43, according to a principle already known from other patents cited previously. Each of the carriage links 92 has two horizontal angles 94 which interact with the grooves of the rollers 90 and has an outer roller 96 capable of bearing on the wall 41Z. The chain sections formed by the carriage links 92 are guided in the way described above by the components 94 and 96, and are held in a substantially stationary position during the rotation of the moving elements 31, 33, in the rectilinear configuration of the needle plates and also in the cylindrical configuration of the needle plates, by pantograph arms 98 (Figs. 34-37 and others) with hinge pins 100 at the movable ends to engage the end chain link of each chain section. Each of the pantograph arms 98 is hinged to an operating shaft 102 carried by a gear box 104; two gear boxes 104 are provided, combined with a central unit 106 which is used to operate the pantograph

arms in order to hold the chain sections in each of the conditions in which these pantograph arms have to come into operation. The chain links 92 of each section carry a plurality of known mechanisms for knitting, which are designed to be operated for the arrangement of the chain sections in the various working configurations described above and below and which are substantially partly equivalent to what has been described previously in other preceding patents cited above. Suitable locking means may be provided to fix the position of the chain sections during the working of the circular needle plate configuration as will be specified subsequently.

The textile mechanisms carried by the links 41, 43 are designed to interact with the needle plate sections 43 in each of the configurations in which these needle plate sections can operate. These textile mechanisms - the concept of which is already known - comprise (Figs. 19 to 21) magnetic selectors for the butts of under-needles and needles, as indicated by 110, needle operating cams as indicated by 112, and thread guide systems which are also movable.

During working, the needle plates have to be butted against each other in an extended rectilinear needle plate configuration, as described initially (Figs. 1 to 11) and with the interposition, if necessary, of portions of needle plates, to produce the seam along the transverse line CC at the crutch. The number 122 (Figs. 20, 23, 24, 25 and others) indicates two slides which can slide in the direction of the arrows fE and in the opposite direction, orthogonally with respect to the alignment of the rectilinear needle plates which are to be joined. These slides carry the portions of needle plate, in other words the intermediate needle plate segments 41I and 43I corresponding to and entirely similar to 41, 43; the slides 122 have to be driven by suitable actuators along sliding guides of the platform 25 to approach each other in synchronization with the approach in the

orthogonal direction of the two rectilinear double needle plates which have to approach each other in the direction of the arrows fC, with the ends of the needle plate sections 43Y and of the guides 78. Each of the slides 122 has within it two approximately semi-cylindrical housings 124, designed to be capable of interacting with the appendages 76 described previously and carried by the profiled bodies 43Y of the needle plate sections at the inner ends. With the synchronized approach in the direction of the arrows fE of the slides 122 and in the direction fC of the assemblies 31, 33 of the two moving elements with the needle plates for the formation of the legs, the inner ends of the rectilinear needle plates are joined, and the profiled bodies of the needle plates 43Y join the slides 122 which are joined together; this causes the two projections 76 to engage in the cavities or housings 124 of the slides 122. A further engagement of the articulated mortise type may be provided between the end profiled bodies 43Y and the slides 122. With these couplings, the needle plate sections 41 and the needle plate sections carried by the slides 122 are aligned to form extended rectilinear needle plates. In this phase of working, the needle plate sections 41 continue the formation of the legs, while the needles of the central needle plate sections carried by the slides 122 (corresponding to the intermediate sections 10 in Figs. 6 to 8) form a seam at the crutch as indicated by CC in Figs. 10 and 11. After the said transverse seam CC has been made at the crutch by means of the needles of the intermediate needle plate sections carried by the slides 122, a start is made - as for the toes - on the initial formation of the body part CP, keeping the needle plates in an extended rectilinear configuration, until a sufficient quantity of fabric is available between the seam CC and the working edge of the body CP being formed.

When this first part of the working of the body has been completed, it is possible to complete the body CP

in the same configuration of extended double needle plates, and then to form the elastic hem and release the article, with a limited separation between the opposing needle plates if necessary. Alternatively, the configuration of the extended rectilinear needle plates may be changed to a circular configuration (Figs. 21, 22, 31, 32, 38) with all the needle plate sections - including those of any components 122 - to form a substantially circular needle plate having a greater diameter than that of the circular needle plates formed on the moving elements 31, 33; the transformation has to take place with an interruption of the working of the body, and this takes place as a result of the activation of the motorized actuators 54 and of the actuators 50 which make the outer ends of the rectilinear extended needle plates approach each other, and the movement of the slides 122. In order to ensure the correct movement of these needle plate sections, the slides 122 may be fitted with means to complete the formation of an operating articulation with links such as 49. For this purpose (Figs. 39-42 and others), in the first place, each of the slides 122 is provided with a hinge pair 147 (equivalent to 47 on the profiled bodies 41) for two links 149 corresponding to the links 49 and connected by toothed sectors similar to 49A; the links 149 at the outer end opposite that of the hinge 147 are engaged or engageable in two movable pins 130, which are carried by a moving element 132 operated by a pneumatic cylinder and piston system 134 capable of raising and lowering the pins 130. The two end profiled bodies 41Y, which join the slides 122 in the movement in the direction of the arrows fC, have two special links 49K which are end links positioned in a way controlled by the articulation formed by the calliper links 49 of the group of needle plate sections which have participated in the formation of the legs; these end links 49K are engaged by the pins 130 which are raised at the correct time after the joining of the rectilinear needle plates in the

direction of the arrows fC against the slides 122, which in turn have been joined in the direction of the arrows fE; in this way (see Figs. 28, 31, 41, 44) the links 149 and 49K are used to complete a calliper link articulation between the aligned needle plate sections of each of the extended needle plates which are used for the formation of the seam CC and of the first part of the body. To transform the extended rectilinear double needle plates to the circular configuration, the outer articulations formed by the appendages 60 (corresponding to the articulations 7 in the initial diagrams) must travel with the slides 64 along centripetal radial paths whose lengths are greater than those travelled by the sections 41 on the single moving elements 31, 33 in reaching the circular configuration. For this purpose (Figs. 54 to 58 and others) the actuator 70 is used to propel the slides 64, while to join the jaws 62 the convergence of the cams 68 is modified by the intervention of a motor 73 with two opposing screws 73A, which acts on the arms 68A of the cams 68 which are hinged at 68B.

When, in the extended rectilinear needle plate configuration, a sufficient number of rows of knitting of the body has been produced to enable the article to be expanded to a circular configuration for the completion of the working with a circular needle plate, the slides 122 are moved progressively and in synchronization away from each other in the opposite direction to the arrows fE, and simultaneously the actuators 54 and the actuators 70 are activated in synchronization so that the pins 76 remain pressed against the housings 124 of the slides 122, following their movements, while the needle plate sections 41, 43 are moved with the calliper links 49 described previously and connected by means of the links 149 and 49K between the group of needle plate sections on one side and those on the opposite side with respect to each of the slides 122. Obviously, during this transformation from a rectilinear extended double needle plate to a circular

needle plate of greater diameter, the working is interrupted until the circular configuration of the needle plate sections is reached and until the locking with the pin systems 80 for this configuration has taken place.

At the time of the separation of the slides 122 for the transformation of the extended rectilinear double needle plates to a circular needle plate of greater diameter, the shelves 33 of the two moving elements may additionally be joined so that the flattened edges of these shelves 33, which are substantially circular but with a segment missing, are in practice joined. This additional approach of the shelves 33 of the two moving elements 31, 33 may also be avoided. To achieve this, each of the needle plate sections on the slides 122 may be extended with a greater number of needles (to the advantage of the article which has an extended seam line CC).

Working with the extended double needle plate for the initial formation of the body and with the cylindrical needle plate of greater diameter is carried out with the simultaneous interaction of the textile mechanisms of each of the chain sections which have worked, in the formation of the legs, with their corresponding short needle plates for this formation of the legs. The sum of the two chain sections which have worked for the two legs practically corresponds to the length of the extended rectilinear double needle plate for the formation of the closure CC and the initial formation of the body and also corresponds to the cylindrical extension of greater diameter for the complete working of the body CP and of the elastic hem or equivalent as indicated by BE. The two chain sections are held in a substantially stationary way by pantograph systems 98, 100 described previously, whose configuration will have been modified on each occasion to follow the transformation of the needle plate configurations.

By a method which is known and entirely similar to the specifications of the preceding patents cited above,

systems of tensioning of the article and systems of removal by pneumatic conveyer after the release of the finished article are provided during the working of the article.

After the formation and release of the article, the whole of the machine has to return - by movements which are the reverse of those described previously - to the conditions in which it can start the working of an article again from the end with the closed toe CG as described in Figs. 9 to 11, with the release of the links 49K from the pins 130, the separation of the two moving elements 31, 33 from each other, the return of the needle plate sections to the short rectilinear needle plate configuration for the formation of the toes of the legs, and the return of all other mechanisms to the conditions specified and described previously for the start of working.

The number of needle plate sections provided for working of the type mentioned is relatively high, while at the same time each needle plate section has to comprise a plurality of needles which when combined with the needles of the adjacent sections has to form a sufficiently large and regular needle bed to carry out the working. Clearly, the possibility of modifying the configuration of the needle plate sections from the conditions of alignment in rectilinear needle plates to the conditions of circular disposition - particularly with two different diameters - makes it necessary to find a compromise in the geometrical conditions of the position of the needles and in particular of the working points of the needles in the various configurations which the needle plate sections must assume. It is possible to have an embodiment of the needle plate sections with the needles perfectly aligned in a rectilinear formation (Fig. 52), or with the needle plate sections having needles which are arranged in curves which may also be arcs of a circumference with a suitably chosen radius; this radius may correspond to one of the

radii of the configurations which the needles have to assume in the circular disposition of the needle plates. One possibility is to place the needles of the various needle plate sections in a disposition corresponding to the curvature of one or other of the circular configurations of the needle plates. Another principle may be the provision of a curvature corresponding to an intermediate value between the two curvatures of the circular configuration with the lesser diameter and with the greater diameter, or any other possible disposition, which may also be designed as a result of experimental tests. Figs. 49 to 51 show a selection of a curvature which substantially corresponds to the curvature of the configuration which the needle plate sections assume in the cylindrical conditions for the formation of the leg, so that the needles are not particularly suitable for the rectilinear configuration of the needle plates or for the circular configuration of greater diameter for the partial formation of the body. From the textile point of view, any suitable system may be used, either as regards the problem of the opening of the needle blades (which may also be done with compressed air), or as regards the positions with respect to each other which must be maintained in the various critical conditions by the end needles of each needle plate section, and in particular by the end needles of each of the end needle plate sections, such as 1A1 and 3A1 and those of the sections 43X and 43Y, during the transformation from the rectilinear to the curved configuration, as well as for the positions with respect to each other of the inner needle plate sections 41Y and the needle plate sections carried by the slides 122.

The system of links 49 and actuators 54 and the slides 64 are provided to change the configuration of the needle plate sections; in particular, the operation of the slides 64 assists the function of the actuators 54 designed to operate the articulations formed by the calliper links 49, which transmit the movement pair by

pair. An additional third device may be provided to facilitate the said change of configuration. On and in the shelves 33 are slides 200, which are suitably guided in sliding seats 202 on the said shelves 33, and which at the correct time engage with and release the actuators 54 by means of locking means 204 of the cylinder and piston type or similar; the said slides 200 (Fig. 56) are operated at the correct time by suitable actuators 206 with threaded shafts 206A, which draw them outwards from the tubular shafts 31 during the transformation of the short needle plates for the legs from the rectilinear configuration to the curved configuration, and for any reverse operation for the transformation of the configuration from curved to rectilinear. The slides 200, which are slidable in the said guides 202, are made inactive by disengagement of the locking systems 204, in the conditions of working with the needle plates combined, since the movement of the slides 200 is no longer required when the movement of the slides 122, which withdraw from and approach each other in the direction of the arrows fE, takes place. To sum up, at least two of the three systems - the actuators 54, the slides 64 and the slides 200 - and preferably all three systems together, are used to carry out the transformation of configuration from rectilinear to circular and vice versa. A group of three systems - the actuators 54, the slides 64 and the slides 200 - is provided to carry out the transformation of the rectilinear and circular configurations in the extended needle plates; at least two of these systems must operate, and the synchronized operation of the three systems is preferable.

It may also be advantageous to provide a disposition to ensure the positioning of the chain sections with the links 92 carrying the textile mechanisms when circular configurations of the needle plates are provided. For this purpose, a disposition illustrated in Figs. 21 and 33 to 39 may be provided. In these figures, equivalent or corresponding elements are indicated by the

same reference numbers as those used in the preceding description. On the base table 23 of the frame 21 there is provided, on each of the two sides of the whole machine, a box 301 with suitable actuators which permit angular and vertical movements of pairs of coaxial shafts 303 and 305, which are integral with sector arms 307 and 309. The sectors 307 carry a set of jaw members 310 disposed in an arc, in other words a sector with a diameter corresponding to that of the chain sections in the formation of a circular needle plate of greater diameter for the formation of the body; on the sectors 309 there are mounted similar jaw members 312 in a curved disposition with a diameter corresponding to that of the needle plates in a circular disposition for the formation of the legs. The sectors 307 and 309 can be moved vertically to reach the same level of operation on the chain sections, by the jaw members 310 and 312 respectively, when the circular configuration for the formation of the body or for the formation of the legs respectively is reached. The function of the jaw members is to lock the carriage links 92 and the chain sections in the conditions of operation of the textile mechanisms carried by the said chain sections in the conditions of rotating circular needle plates.

Reference should be made, for example and in particular, to Fig. 37 which relates to the operation of the sectors 307 - although the operation of the sectors 309 is entirely similar - when these sectors 307 reach the active position, joining the needle plates in the circular configuration. Each jaw member 310 of the sector 307 has two forked jaws, an upper one 314 and a lower one 316, symmetrical with respect to each other, each having two forked appendages facing the needle plate with inclined contact surfaces; each of the two jaws 314 and 316 is driven by an actuator 314A and 316A respectively, so that the inclined and opposing surfaces of the two jaws 314 and 316 can be separated from or tightened on each other. Each

link 92 of the chain has an upper central appendage 92K with lateral projections inclined in a complementary way to the surfaces of the inner appendages of the jaws 314 and 316, to interact with them. In the central portion, the upper appendage 92K has a sliding seat for a transmission chain comprising a pin 318 projecting externally towards the sector 307, a slidable column 320 and a slider 322, which are interconnected slidably with inclined planes; in this way, a thrust in the direction of the arrow f318 on the pin 318 causes a thrust in the same direction on the slider 322. This slider is connected through a plate 324 to the support of the roller 96 which is slidable on the link 92 parallel to the arrow f318 and parallel to the slider 322; an elastic system which acts on the slider 322 produces a thrust of the roller 96 against the wall 41Z of the support 41, while the thrust on the pin 318 causes the roller 96 to withdraw from the said wall. When a sector, for example sector 307 (or 309) joins the chain sections to lock them, it acts first on the pins 318 in the direction of the arrows f318 and causes, in the way stated above, the rollers 96 to withdraw from the walls 41Z of the supports 41. Immediately afterwards, since the jaws 314 and 316 have been separated in the approach of the sectors 307 or 309, the actuators 314A and 316A of the said jaws 314 and 316 cause the jaws 314 and 316 to approach each other, and these engage with the inclined lateral profiles of the upper appendage 92K of the link 92, thus causing a slight action of moving the links 92 towards the active sector 307 (or 309) and thus a slight withdrawal of the angles 94 from the rollers 90 and the locking of the links 92 to the active sector 307 (or 309), so that the positions of the chain sections, and consequently those of the textile mechanisms associated with the said sections, are stabilized. The sectors 307 or 309 activated by joining to the chain sections are locked suitably in the active position by pin members interacting with the corresponding

shafts about which the said sectors move angularly. In this way the rigid positioning of the chain sections is ensured during the activity on the needle plates which rotate in the circular configuration.

The end links of the chain sections may also be made in the way indicated above, with the locking systems being suitably taken out of alignment with the articulations 100 of the pantograph members 98.

Other solutions may also be used for locking the chain components such as 92 (and if necessary for the profiled bodies such as 41 of the needle plates). For example, it is possible to provide locking pins operated by pneumatic or hydraulic actuators incorporated in the chain links, to enter corresponding sockets in a fixed structure, in the conditions in which the chain links are to be locked; the actuators may be operated by a single circuit common to all of them, with flexible connectors.

Figs. 60 to 68 show a modified embodiment of the structure of the chain sections. In this embodiment, each chain section structurally consists of a flexible strip - normally metallic - to which are applied individual bodies, equivalent to the carriage links 92 in the preceding examples, to carry the textile mechanisms designed to interact with the needles. In this variant embodiment, as illustrated, each chain section structurally consists of a flexible strip 440, made for example of piano wire steel or the like.

The number 441 indicates profiled bodies equivalent to the bodies 41 in the preceding example, to support the needle plate sections 443 equivalent to the sections 43. The number 447 indicates pins for links 449 equivalent to the links 49 and for the functions described previously. Each body 441 carries two lower rollers 452, with vertical axes spaced apart to a limited extent, and further corresponding upper rollers 452S facing in the opposite direction to the rollers 452. In an intermediate position between the two lower rollers 452 and between the

two upper rollers 452S there is provided a movable roller 454 and 454S; each of the rollers 454 and 454S is provided with an annular rim 456 and 456S which projects radially and which grazes the rollers 452 and 452S respectively along the outer angle of the rollers of this pair of rollers. In this way a housing is formed for the strip 440, which can slide between the rollers 452 and 452S on one side and between the rollers 454 and 454S on the other, and the longitudinal edges of this strip 440 are held by the annular rims 456 and 456S. The rollers 454 and 454S are carried by forked levers 458 and 458S, which are hinged in an intermediate position on the profiled bodies 441 by pins 460 and 460S. The forked end of one forked lever 458 and 458S corresponds to and interacts with a pin 462 of a profiled body 441, arising from a lateral projection of each profiled body 441; this projection is housed in a corresponding cavity 464 of the adjacent body 441. When the profiled bodies 441 are joined together in the rectilinear needle plate configuration, the pins 462 enter the forked ends of the corresponding forked levers 458 and 458S, forcing them to rotate slightly until the rollers 454 and 454S are joined towards the alignment between the rollers of the pairs of rollers 452 and 452S of the corresponding profiled bodies 441. In these conditions, the strip chain 440 is guided securely between the rollers 452 and 454 and 452S and 454S, while still being held by the rims 456 and 456S acting on its longitudinal edges. When the profiled bodies 441 are inclined with respect to each other to bring the needle plate sections into a circular configuration, the pins 462 withdraw from the end fork of the corresponding forked levers 458 and 458S, permitting a slight withdrawal of the corresponding roller 454 and 454S from the corresponding rollers 452 and 452S, so that the strip 440 (replacing the chain) is freed from direct and forced contact between the rollers 454, 454S and 452, 452S, which can therefore run with the circular needle plates without in any way

affecting the strip 440 replacing the chain.

The end profiled bodies of each of the groups forming rectilinear needle plates, indicated by 441X and 441Y, which correspond to the end profiled bodies 41X, 41Y, carry on their angles of mutual contact faceted pins 465 and 475, which correspond to the pins 60 and 76 in the preceding example. Additionally, at least one of these end profiled bodies 441X of each pair of these end bodies which are adjacent to each other has a profiled entry lever 466, which is hinged at 468 to one of the said profiled bodies 441X and extends along the inner side of the strip 440 as far as the rollers 452 of the other adjacent end profiled body 441X or 441Y, the said profiled lever 466 being located in an intermediate position between the rollers 452, 452S and 454, 454S; this profiled lever 466 is pressed outwards by a spring 470, and its outer curved back forms an entry profile for the end of a strip 440 of a chain section which has to enter the space between the rollers 452 and 452S and the roller 454 and 454S during the working in the rectilinear configuration of the needle plate sections. It should be noted that the function of these profiled entry levers 466 is combined with the guide function which is provided by the pantograph arms such as 98 described previously, which engage with the end profiled bodies of the chain sections; these pantograph arms tend to push and guide the strip 440 from the outside towards the centre, while the profiled entry lever 466 is caused by the spring 470 to press outwards from the inside on the strip 440 (replacing the chain) to ensure that the end of this strip enters between the said rollers 454 and 454S and 452 and 452S, so that this strip 440 is received and guided by the said rollers 452 and 454, and centred vertically by the edges 456 and 456S.

The flexible strip 440 (acting as a chain) supports elements 476 which correspond to the carriage links 92 of the chain sections in the preceding example,

to support the textile mechanisms which are to interact with the needle plates. The strip 440 therefore supports these elements 476 which are provided with screws 478 with shaped heads to fix the strip 440 but to allow it to bend. These elements 476 are shaped in a way substantially equivalent to what is illustrated with reference to the preceding example. In particular, each of these elements 476 has an appendage 476K equivalent to 92K, and locking systems to interact with the sectors 307 or 309 or with equivalent mechanisms. These elements 476 have, in particular, an external extension 476E, which is used for engagement by the jaws equivalent to the jaws 314 in the said preceding example, and which may also advantageously have on one side an angled projection 476F and on the opposite side a complementary groove 476G; in the rectilinear configuration of the strips 440 along the rectilinear needle plates formed by the needle plate sections, the extensions 476E are therefore in contact with each other and securely connected as a result of the presence of these projections and grooves 476F and 476G, which interlock; in the curved configuration which the strip 440 assumes to follow the circular needle plates, these elements 476 and in particular, the extensions 476E are spaced apart and permit the locking action of the jaw systems carried by sectors such as 307 or 309 or by equivalent dispositions.

To ensure the entry of the strip chain, there is provided, in addition to the presence of the lever 466, an actuator - which may be a simple spring 495 (Fig. 66) - capable of imparting a suitable inward inclination to the initial end link of the strip chain; this ensures the entry of this link along the rectilinear guide means.

In this embodiment also, dispositions similar to those in the preceding example will be provided, for the operation of the links 449 by an actuator similar to 54 which acts on links 449B and 449C, links 449K equivalent to 49K, and the like.

In this embodiment also, in which the chains are replaced by strips such as 440, suitable arrangements may be made to facilitate the adoption of the rectilinear and curved configurations and consequently of a configuration of an arc of a circle of the chain sections formed in this way, with dispositions equivalent to those in the preceding examples, starting in particular from the systems of calliper links 449.

Fig. 69 shows a modified solution in which there are needle plate sections 643 equivalent to 43 and 443, which are extended vertically instead of with an inclination approximately in their larger parts, and with only the upper parts inclined and converging upwardly to house the needles 601 slidably; in the approximately vertical portions 603 of the grooves of the needle plates 643, selectors or jacks 605, 607 and levers 609 with butts 605A, 609A are housed. Links 611 are provided for the connection between the selectors or jacks 607 and the corresponding needles 601, and are hinged to the said jacks 607 and to the needles, to provide a thrust and traction transmission between them. Cams and cam followers, such as 615 and 617, are provided to operate the butts 609A of the levers 609 and the butts 605A of the jacks 605.

In all embodiments the position of the hinges between adjacent sections 1A, 1B; 1Y, 3Y; 1003X; 1003Y; 41; 43; 441 and the position of the end needles of each section are such that the loops of the stitches of the fabric formed by said end needles have a dimension substantially equal to the dimension of the loops formed by the remaining needles, at least in the circular configuration of the needles and during the working of the legs of the manufactured article.

It is to be understood that the drawing shows only an example provided solely as a practical demonstration of the invention, and that this invention may be varied in its forms and dispositions without departure from the

scope of the guiding concept of the invention. The presence of any reference numbers in the enclosed claims has the purpose of facilitating the reading of the claims with reference to the description and to the drawing, and does not limit the scope of protection represented by the claims.

CLAIMS

1. Method for the formation of a tubular knitted article with one end closed, by means of knitting needles, characterized in that the initial closed end is initially worked with a substantially rectilinear configuration of the needles on two opposing beds (needle plates), and that the subsequent tubular working is carried out with the needles in one bed in a substantially circular configuration.

2. Method according to Claim 1, characterized in that in each of the configurations, working is carried out by rotation of the needle assembly with respect to the textile mechanisms - needle and under-needle operating selectors, thread guides, and others - which are kept in substantially stationary conditions and in rigidly fixed conditions when the configuration of the needles is circular.

3. Knitting machine for the production of tubular knitted articles with one end closed, characterized in that it comprises needle plate sections which are movable to assume a configuration with two opposing and substantially rectilinear needle plates to obtain, by the interaction between the needles of the opposing needle plates, the initial closing of the tubular article, and a configuration with a substantially circular needle plate; substantially stationary textile mechanisms, interacting with the needle plates in the said configurations, being provided.

4. Machine according to claim 1, characterized by: a moving element capable of rotating about its own axis; on the said moving element, two symmetrical upwardly converging needle plates extending orthogonally to the axis of rotation, for the formation of a tubular knitted article with one end closed; along and around the said two needle plates, guide means for a section of chain carrying textile components - including cams, selectors and thread

guides - capable of interacting with the needles and the under-needles of the said two needle plates; means of rotating the moving element for knitting; and means of holding the chain section in a position stationary on average with respect to the rotating needle plates; and wherein each needle plate consists of a plurality of needle plate sections (1A, 3A; 1X, 3X; 1Y, 3Y), each having grooves for a certain number of needles; wherein the said needle plate sections are interconnected in a hinged way; and wherein means are provided to change the configuration of each needle plate from a substantially rectilinear one with opposing needle plates to a curved one, to form a circular cylindrical needle plate, and vice versa.

5. Machine according to Claim 4, characterized in that

- the needle plate sections (41, 43) of two opposing needle plates are slidably supported by a sliding table (33);
- for each needle plate, an articulated transmission (49, 49A, 52) with an operating actuator (54) is capable of causing the sections to move between a substantially rectilinear configuration and a substantially curved configuration;
- links (60, 62; 76, 78) for the two ends of each needle plate are provided to control their movements between the two configurations while keeping each end close to the corresponding end of the other needle plate;
- in the said table (33), pin means (80), operated at the correct time, are made to project to securely position the said sections (41, 43) of each needle plate in the two configurations; and
- on each needle plate section (41, 43) there are provided guide members (94, 96) to form the guide means for the chain sections (92) in each of the configurations assumed by the needle plate.

6. Machine according to at least Claim 4 or 5,

characterized in that the needle plate sections (41, 43) are hinged by means of flexible strips (45) and in that the said needle plate sections (41, 43) are shaped to be joined with close contact in the rectilinear needle plate configuration.

7. Machine according to at least Claim 5, characterized in that the said articulated transmission comprises pairs of links (49) with calliper joints (52) and with the ends hinged (at 47) to adjacent needle plate sections (41); the two links (49) on each needle plate section being hinged on neighbouring pins (47) and provided with toothed sectors (49A) for engagement with each other; at least one actuator (54) being provided to change the relative angular formation of one (49B, 49C) of the pairs of links (49) with calliper joints, and/or slide actuators (64; 200; 120) to change the configurations of the end needle plate sections.

8. Machine according to at least Claim 4 or 5, characterized in that the needles in each needle plate section (41, 43) are disposed to assume a rectilinear alignment.

9. Machine according to at least Claim 4 or 5, characterized in that the needles are disposed to assume an alignment with a curved profile, with a curvature dependent on the curvature which each needle plate may assume; the curvature of the curved profile of the alignment of the needles may correspond to the curvature of the circumference along which the two needle plates are disposed in the curved configuration.

10. Machine according to at least Claim 4 or 5, characterized in that the guide members on the needle plate sections consist of guide wheels (90) with a profile shaped to engage with complementary shaped profiles (94) formed by the links (92) of the chain sections, the said guide wheels (90) being mounted on axes which are always parallel to each other and in particular vertical.

11. Machine according to at least Claim 5,

Qcharacterized in that one of the said links of two ends of each double needle plate comprises two appendages (60) housed in sockets (62A) of jaws (62) which can be joined together and are carried by a slide (64) made to slide radially by an actuator (70, 72).

12. Machine according to at least Claim 5, characterized in that one of the said links of two ends of each double needle plate comprises two appendages (76) capable of sliding in a V-shaped seat (78, 78A) to be stopped at the end (78A) of the seat when the circular configuration is reached.

13. Machine according to claim 3, characterized by a chain that carries textile components said chain being in the form of a flexible strip (440) to which are fixed elements (476) carrying the textile components designed to interact with the needles of the needle plate sections; and by profiled bodies (441) carrying needle plate sections (443), provided with guide rollers (452, 452S, 454, 454S) for the said strip (440).

14. Machine according to Claim 13, characterized in that the said guide rollers (452, 452S, 454, 454S) are disposed with two (452, 452S) on one side and one (454, 454S) on the other side of the strip (440), means being provided to guide the longitudinal edges of the said strip (440).

15. Machine according to Claim 13 and/or 14, characterized in that it comprises two groups of guide rollers (452, 454; 452S, 454S) with axes transverse to the length of the strip (440) - particularly vertical - and in that in each group at least one roller (454, 454S) has a circumferentially projecting rim (456, 456S) to act on the longitudinal edges of the strip (440) and to guide them.

16. Machine according to at least one of Claims 13, 14, 15, characterized in that at least the rollers (454) disposed on one side of the strip (440) are movable, to eliminate or decrease the contact of the rollers with the said strip, when working with the needle plate sections in

a circular configuration, in other words with a cylindrical needle plate.

17. Machine according to Claim 16, characterized in that the movable rollers (454) of a profiled body (441) are carried by forked levers (458), interacting with pins (462) carried by an adjacent profiled body (441), to withdraw the said movable rollers when the profiled bodies (441) are separated from each other, and to join and activate the rollers when the profiled bodies (441) are joined in the rectilinear configuration.

18. Machine according to at least one of the preceding claims, characterized in that it comprises angularly movable arms (307, 309) provided with means of engagement of components (92; 476) of the chain carrying the textile mechanisms, to lock the said components at least in the circular configuration of the needle plates.

19. Machine according to Claim 18, characterized in that the said means of engagement (310) comprise jaw members (314; 316) with corresponding actuators (314A; 316A) to engage with inclined surfaces of appendages (92K, 476K) of the said components (92, 476) and a transmission (318, 320, 322, 324), to produce the separation between the components of the chain (41, 41Z) and the guide means (90, 96) of these components.

20. Machine according to Claims 18 and 19, characterized in that the said means of engagement (310) are disposed on the said arms (307; 309) in a curved disposition to engage with a plurality of the said components of the chain.

21. Machine according to at least one of the preceding claims, characterized in that it comprises two adjacent moving elements (31, 33) capable of operating independently with a change in configuration of the needle plates between rectilinear and circular; and means of combining the needle plates of the said two moving elements for working a single tubular article as the continuation of the tubular articles produced by the

needle plates of the two moving elements.

22. Machine according to at least Claim 21, for the production of tights (pantihose) and similar, comprising: a central moving element capable of rotating about central axis of its own; two epicycloidal moving elements, mounted on the said central moving element and rotating about their own shafts out of alignment with the central axis; on each of the said epicycloidal moving elements, two symmetrical rectilinear upwardly converging needle plates with their extension orthogonal to the corresponding axis of rotation, for the formation of a corresponding leg with a closed end; along and around each of the said double needle plates, guide means for a chain section with carriage links carrying textile components - including cams, selectors and thread guides - capable of interacting with the needles and the under-needles of the corresponding double needle plate in each configuration assumed by it; means of combining the said double needle plates and forming an extended double needle plate and of creating guide means along and around the said extended double needle plate for the said chain sections, for the formation of a body with no interruption between it and the legs; means of rotating the two epicycloidal moving elements for knitting the legs and means of rotating the central moving element for knitting the body; and means of holding the chain sections in a position which at least on average is stationary with respect to the rotating needle plates; the said machine being characterized in that each of the two extended needle plates is also capable of assuming a semi-circumferential configuration, the outer ends (60) of the outer sections (43X) of the butted needle plates being kept adjacent and the inner ends (76) being separated to make the extended needle plates assume the said semi-circumferential configuration.

23. Machine according to Claim 22, characterized in that it comprises intermediate needle plate segments (10; 1010; 122), which are interposed between the inner end

sections (43Y) of the butted needle plates, to form substantially continuous extended needle plates; the said intermediate needle plate segments being carried by slides which are slidable orthogonally to the configuration of the extended rectilinear double needle plates.

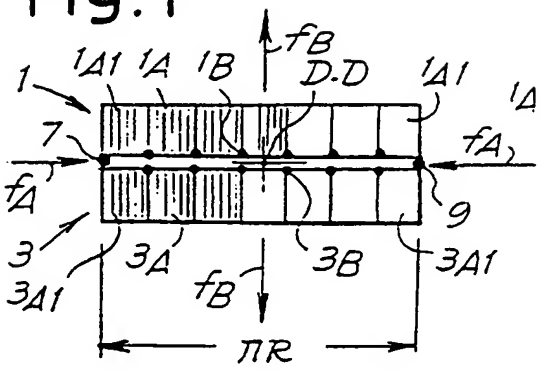
24. Machine according to Claim 22 or 23, characterized in that the said epicycloidal moving elements are mounted with axes (K-K) fixed with respect to the axis (H-H) of the central moving element, and in that the said intermediate segments (1010) have lengths corresponding to the space between the aligned rectilinear double needle plates (1001X, 1003X; 1001Y, 1003Y), and such that the circular configuration can be produced by the centrifugal radial movement of the said intermediate segments (1010) and the centripetal movement of the combined outer ends (1007).

25. Machine according to Claim 24, characterized in that the epicycloidal moving elements are rotated with an angular phase displacement, to prevent instantaneous conditions of alignment.

26. Machine according to one of Claims 1 to 25, characterized in that each needle plate section (643) has a substantially vertical portion containing selector members such as jacks and/or levers (605, 607, 609) and an inclined section containing the needles (601), and in that the connection between the said selector members and the said needles is made with links (611) hinged to them.

27. Process and machine for knitting tubular articles with one end closed, with needle plates having a modified configuration; the whole as described above and represented by way of example in the attached drawing.

Fig.1



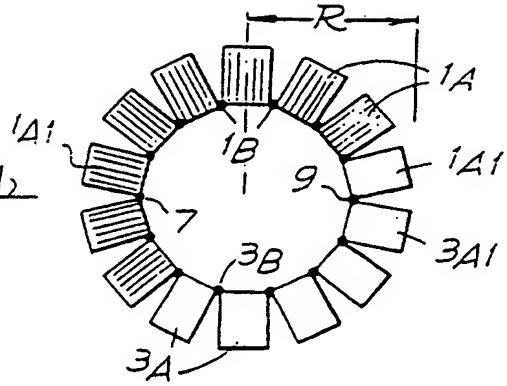


Fig.2

Fig.3

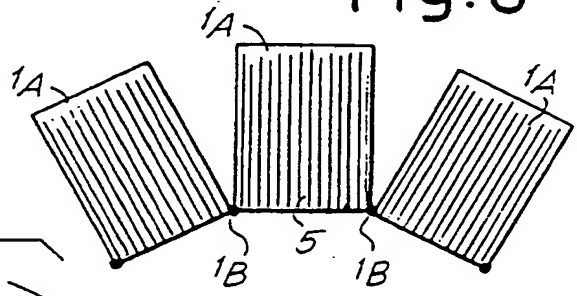


Fig.4

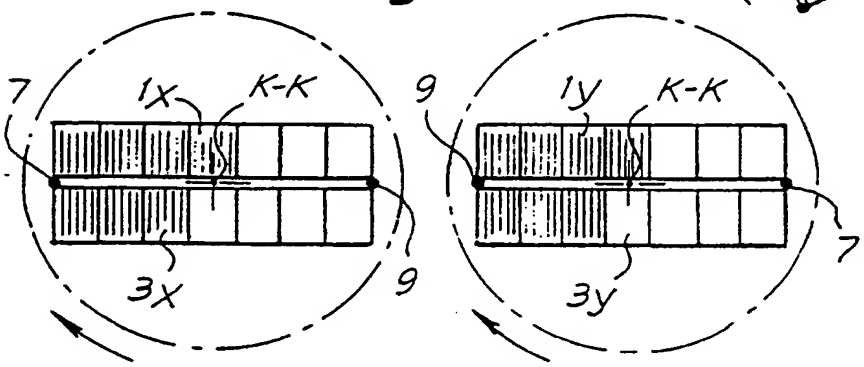


Fig. 5

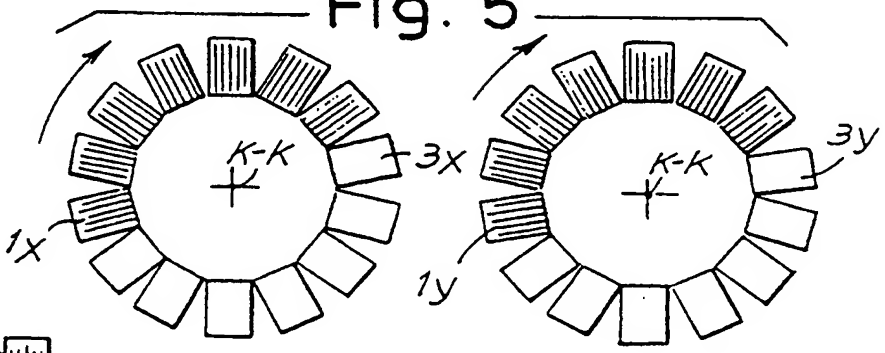
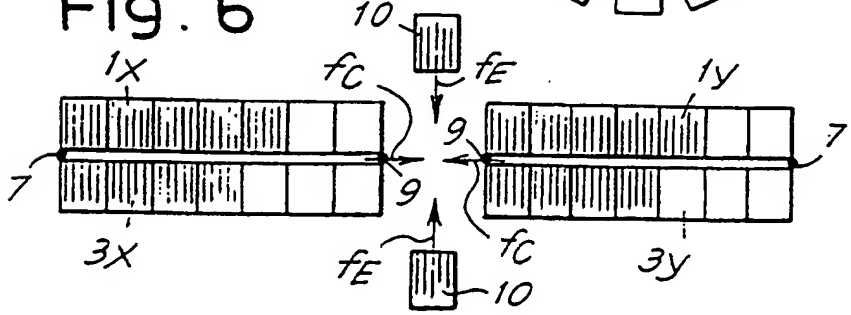


Fig. 6



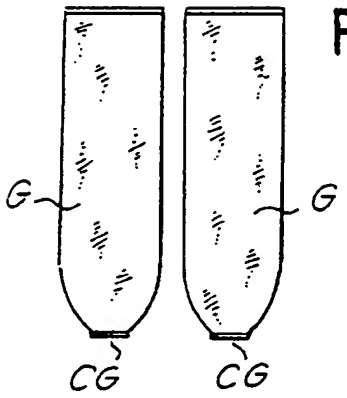
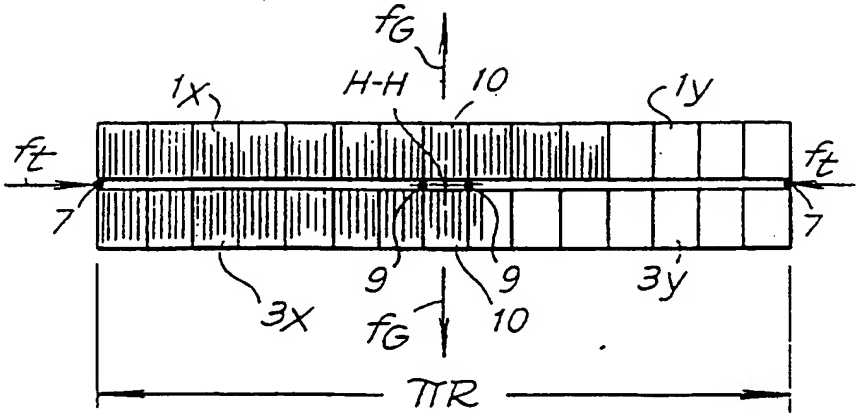


Fig. 9

Fig 7



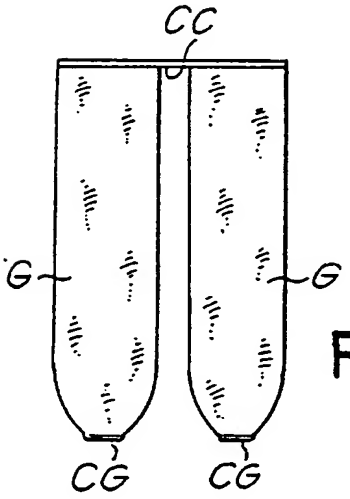
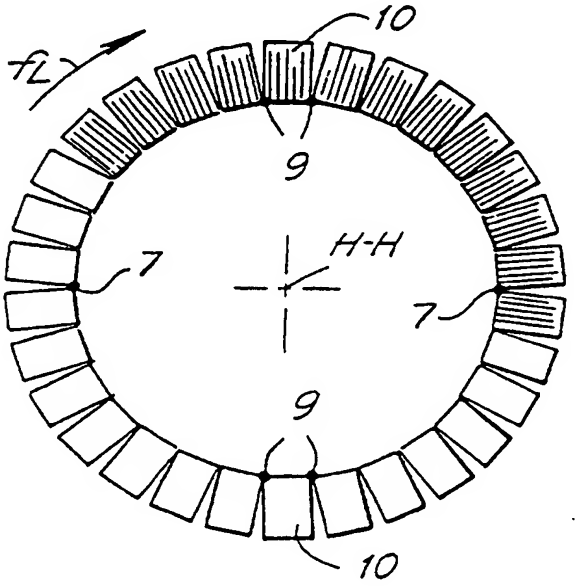


Fig. 10

Fig. 8



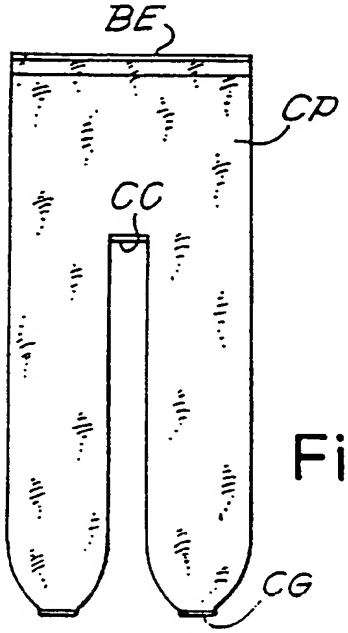


Fig. 11

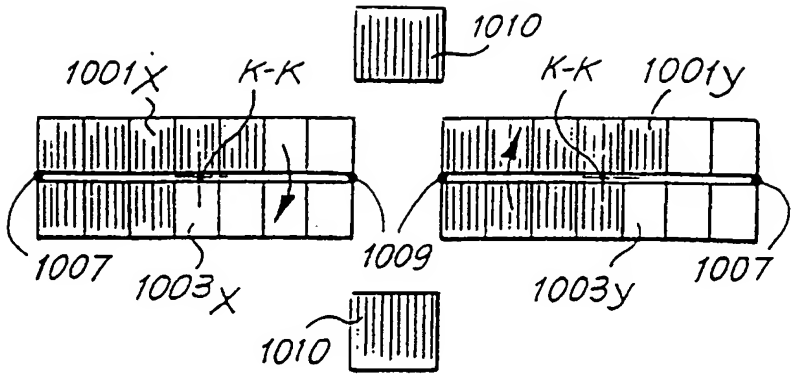


Fig.12

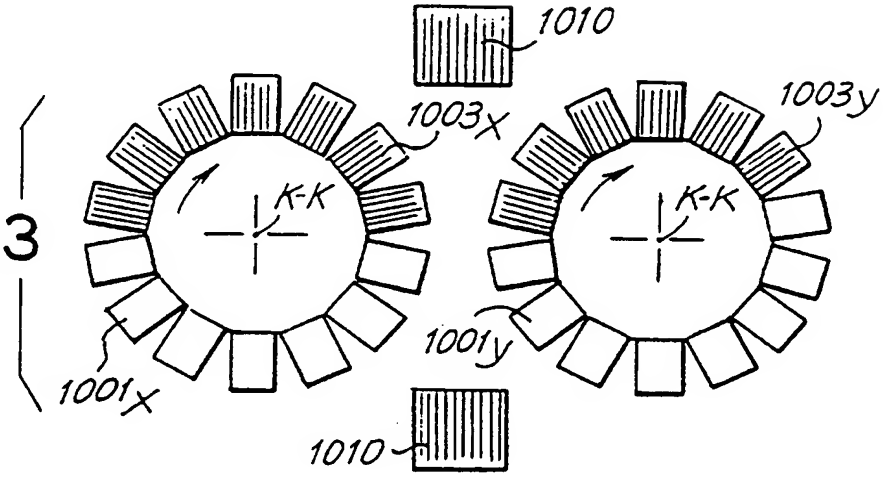


Fig.13

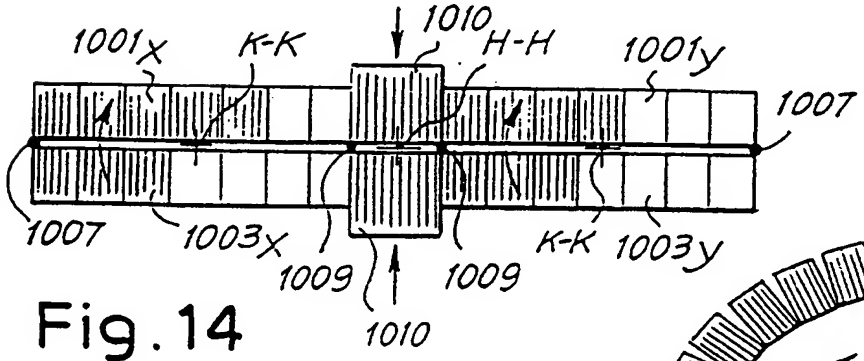


Fig.14

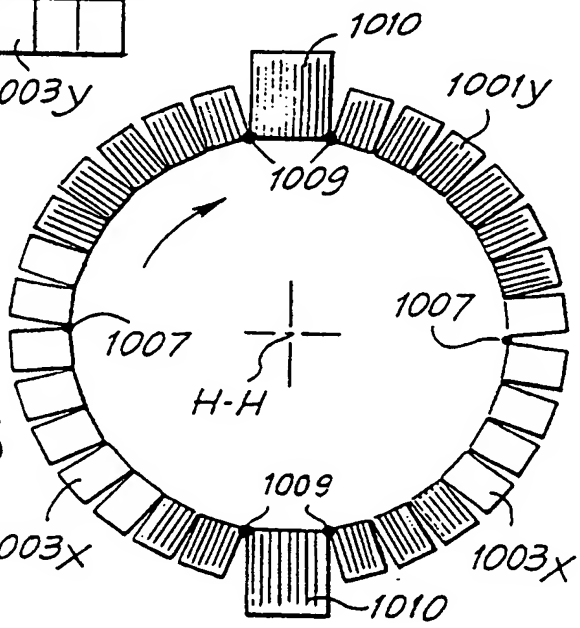
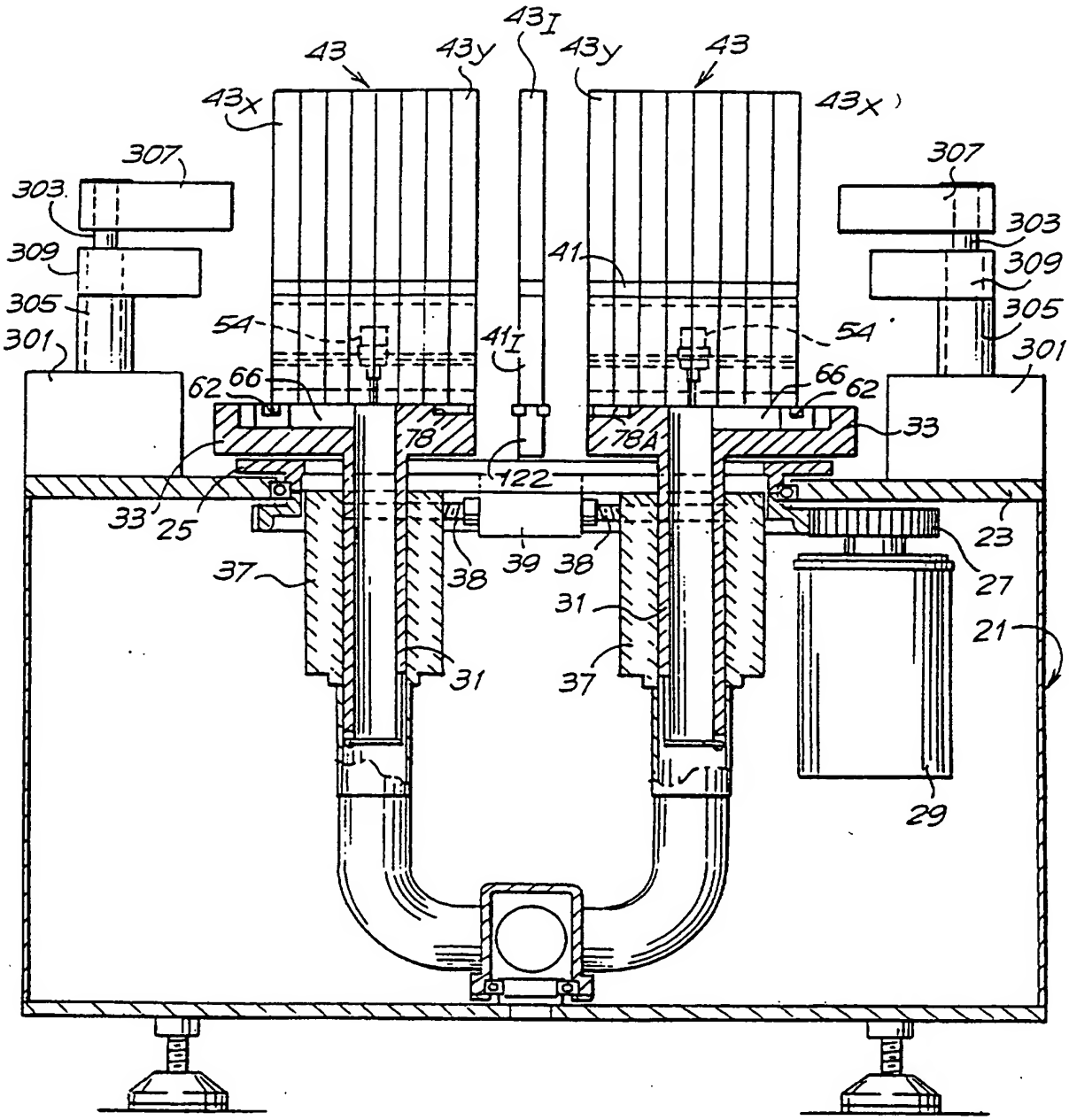


Fig.15

Fig. 16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43x
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41I
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66
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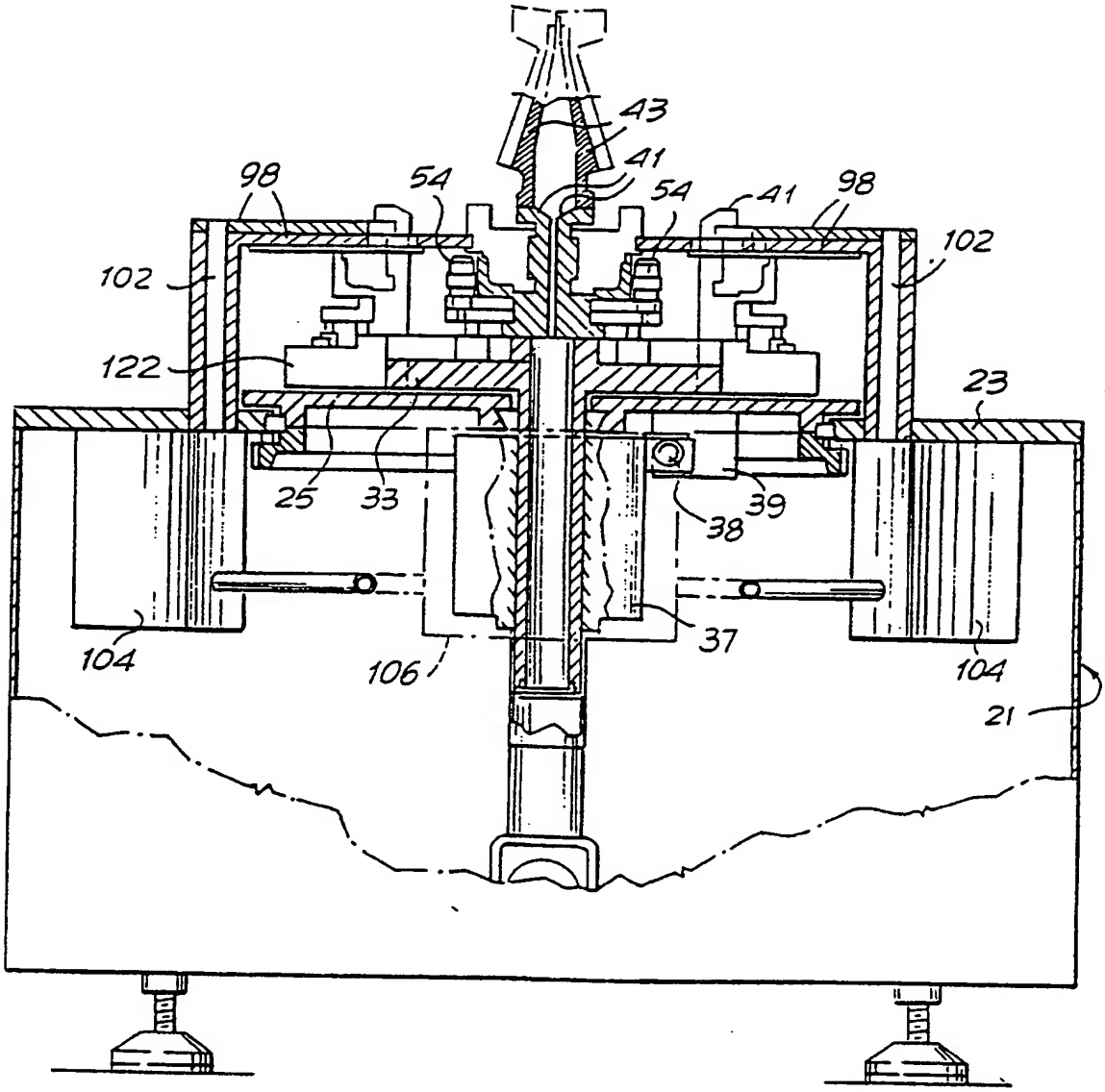
Fig. 17



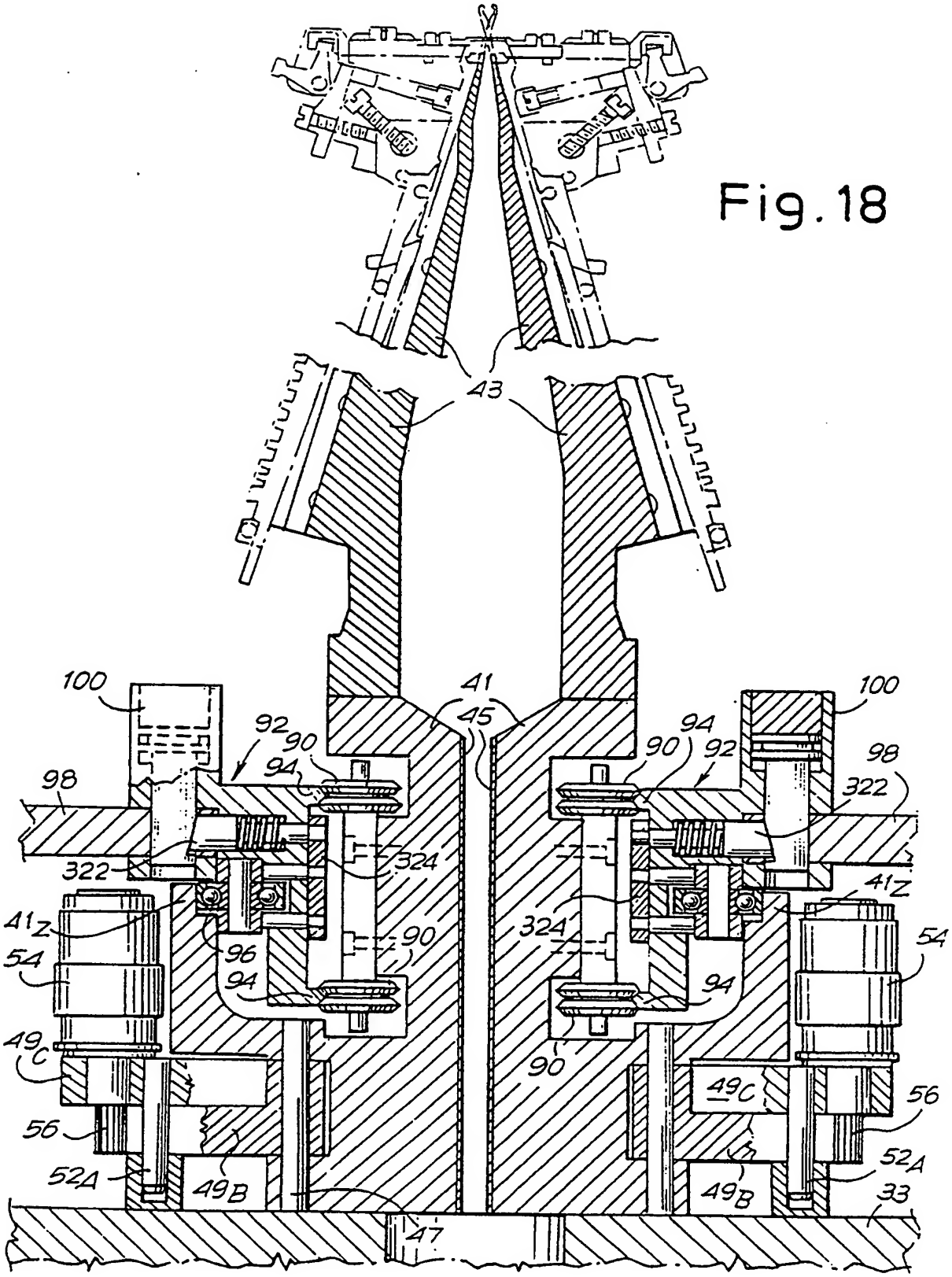
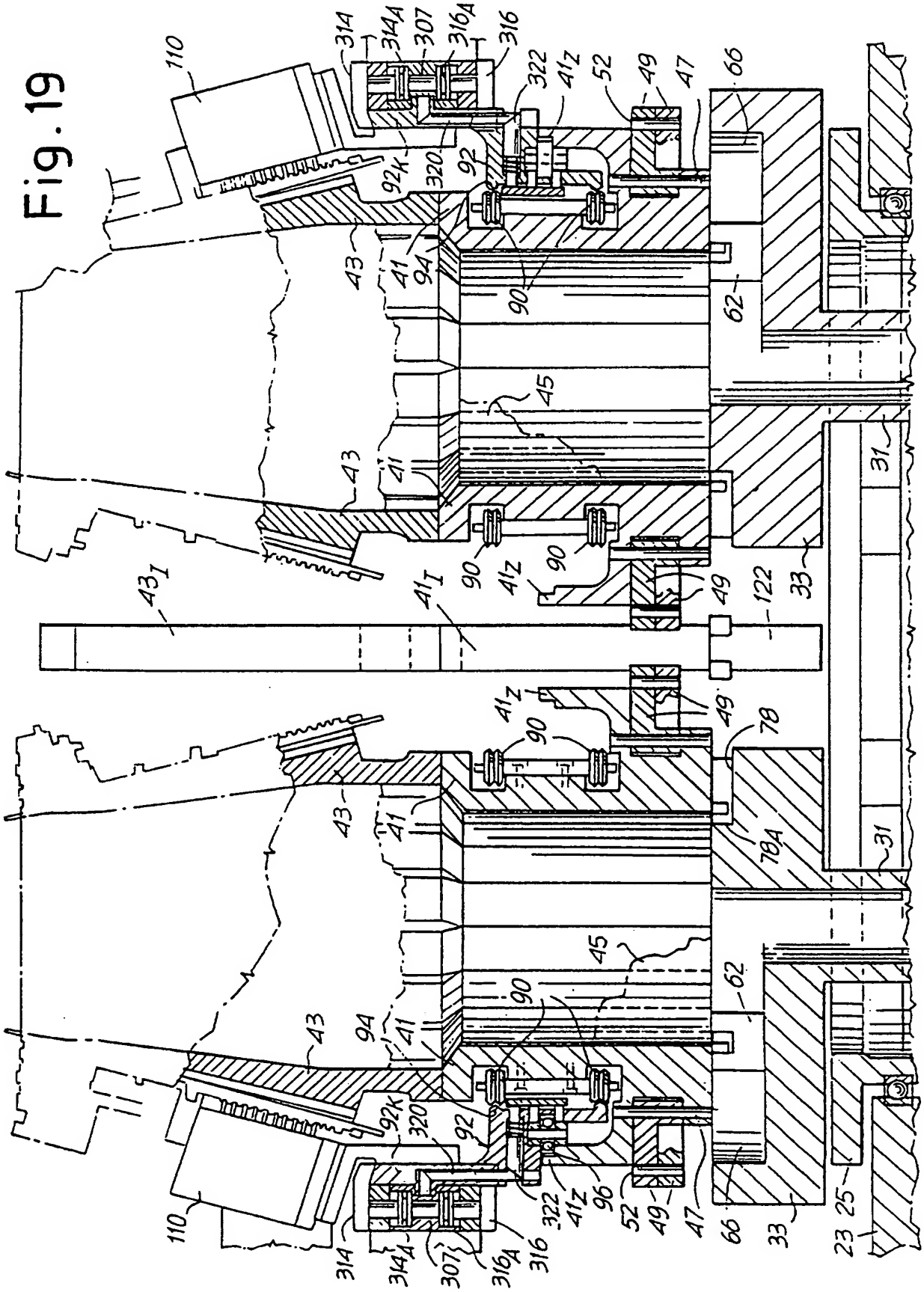


Fig. 18

Fig. 19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78A
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25
23

Fig. 20

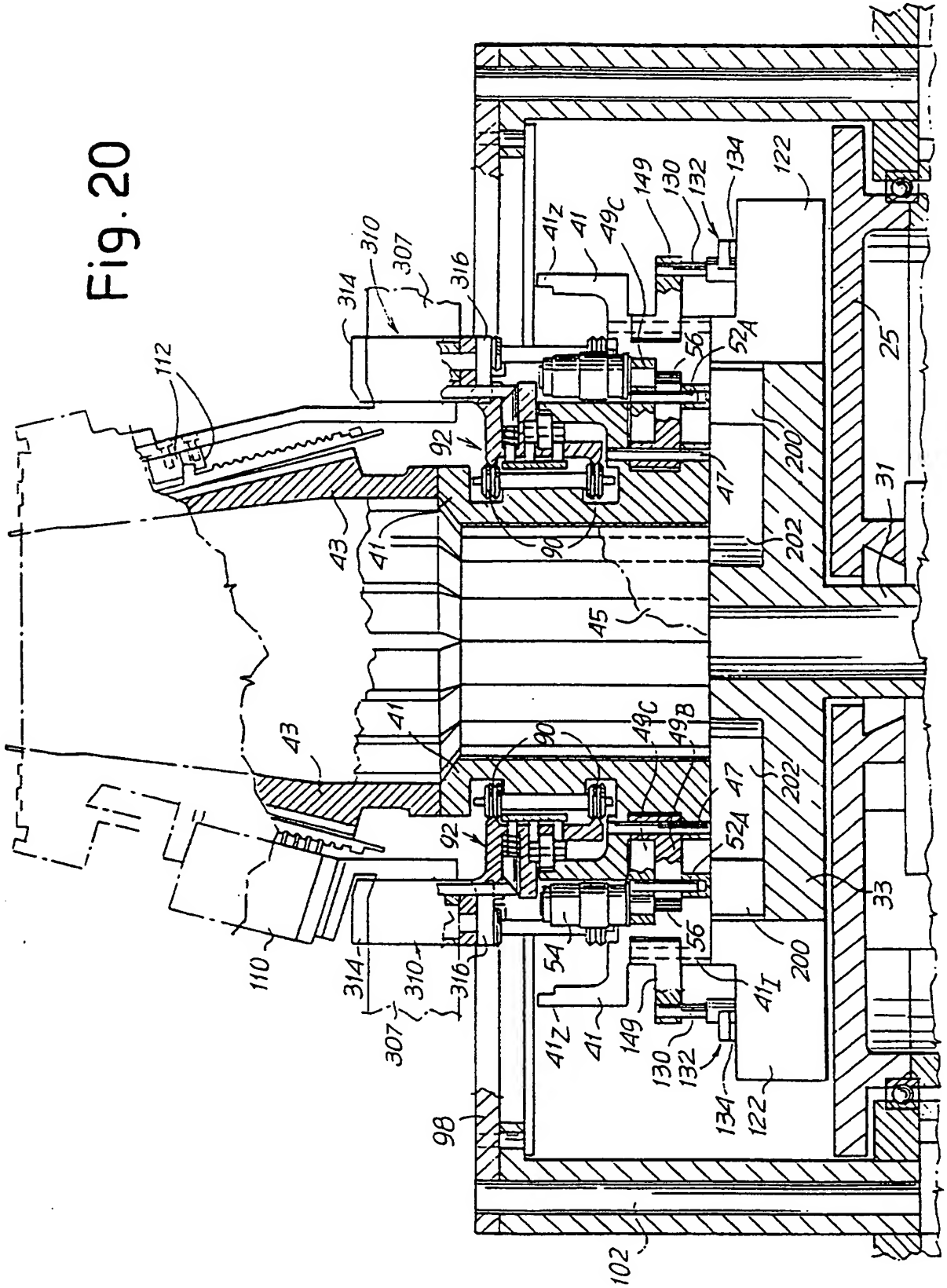
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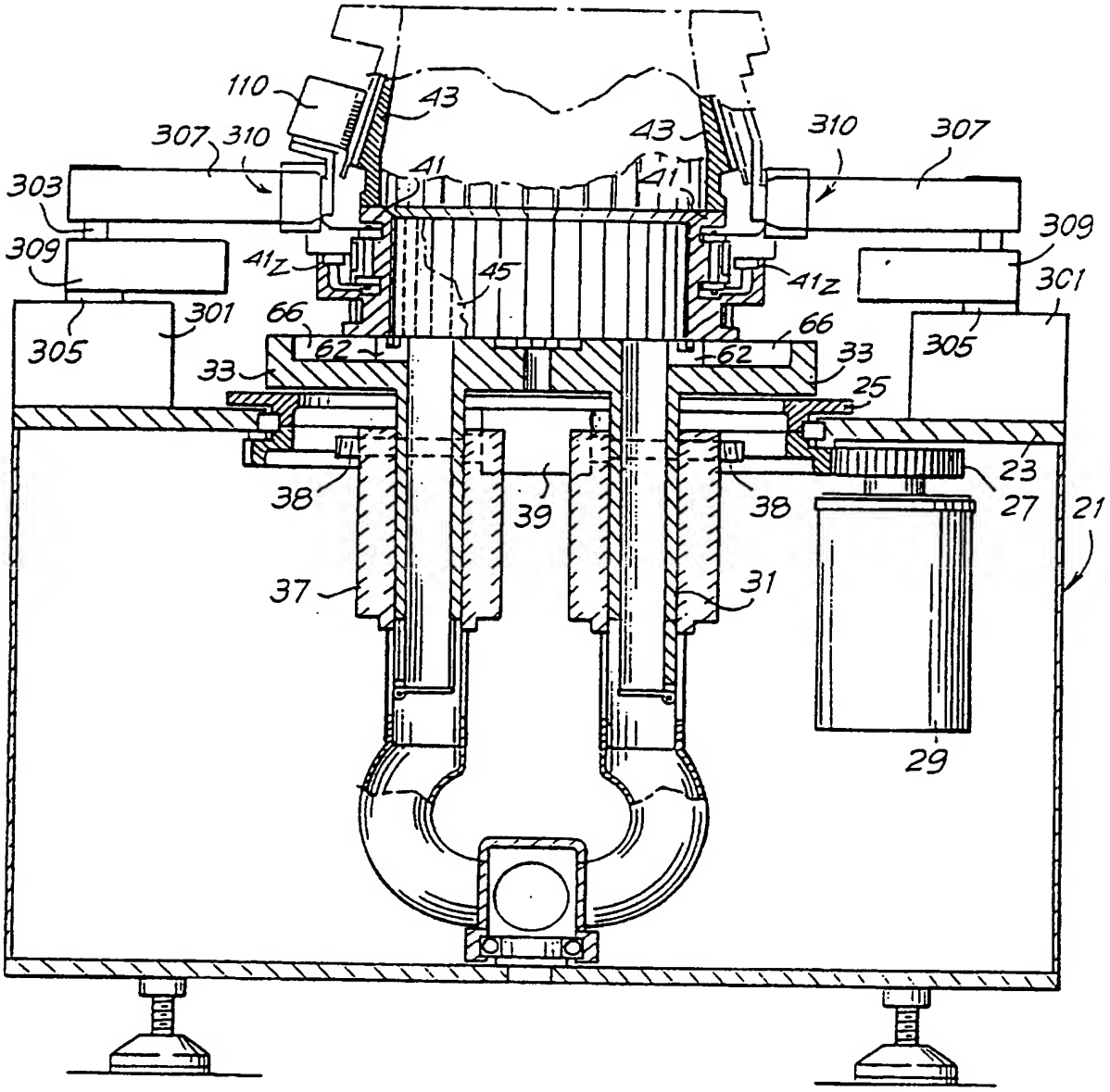
Fig. 21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41z
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41z
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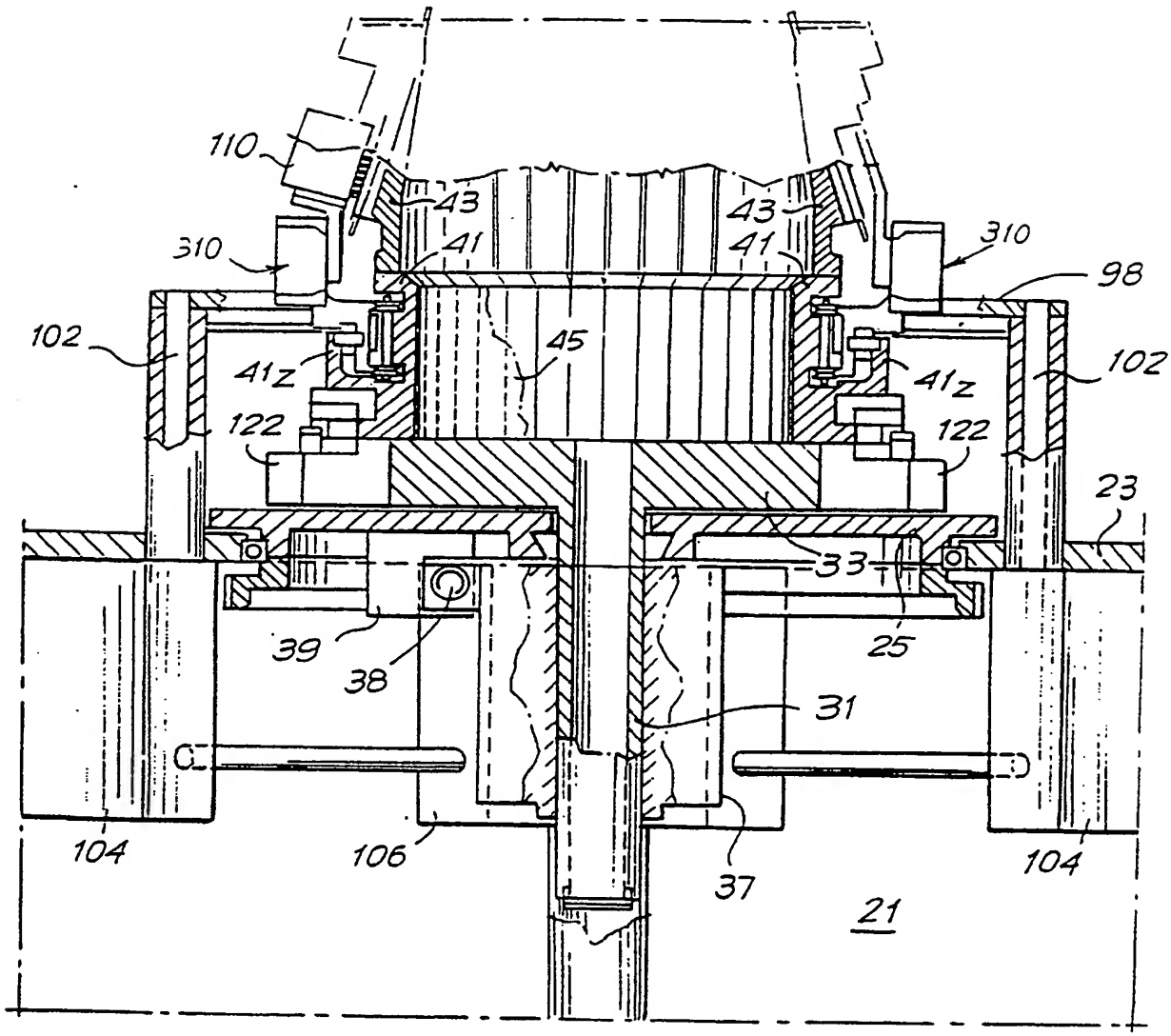
Fig. 22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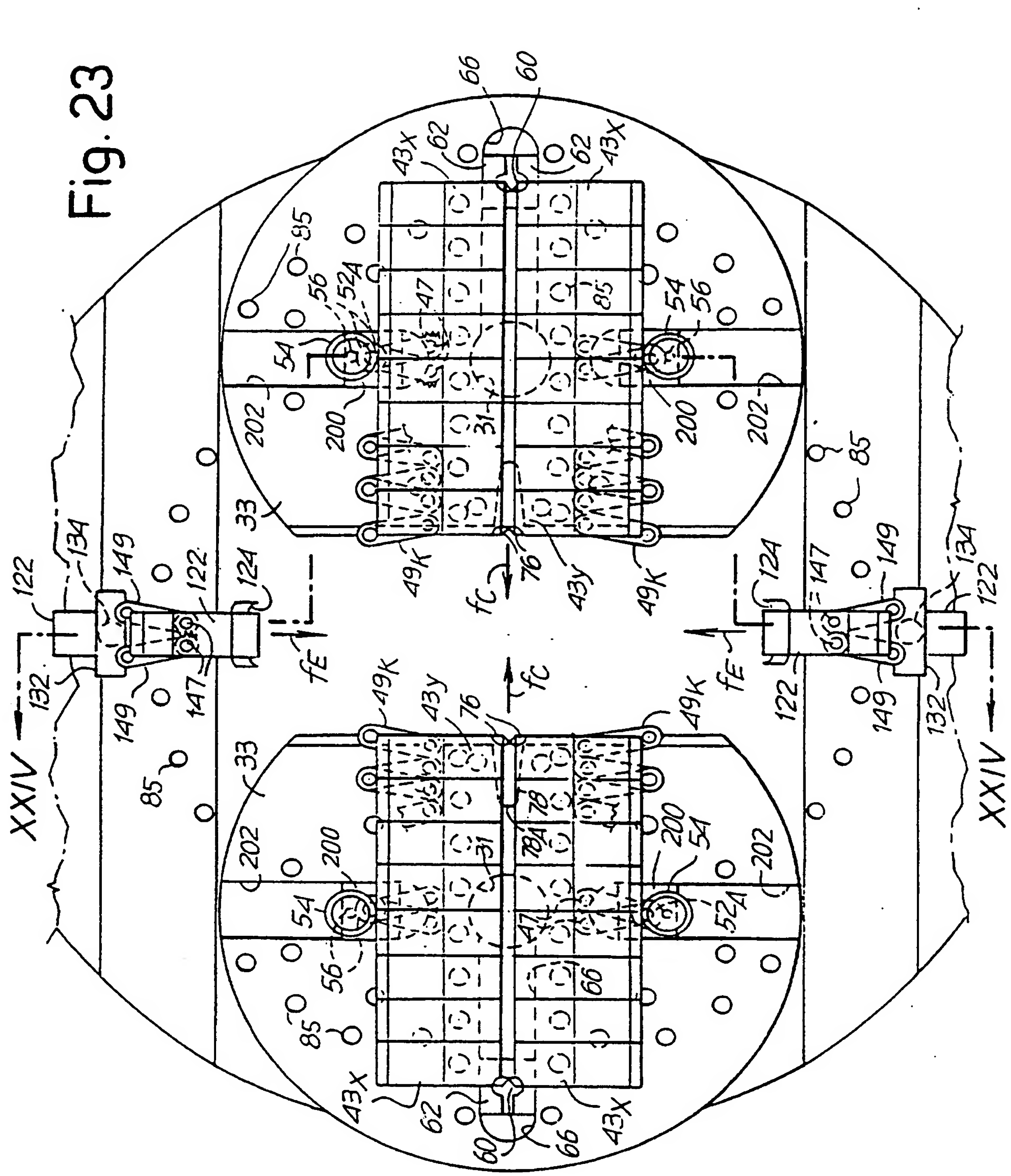
21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43X
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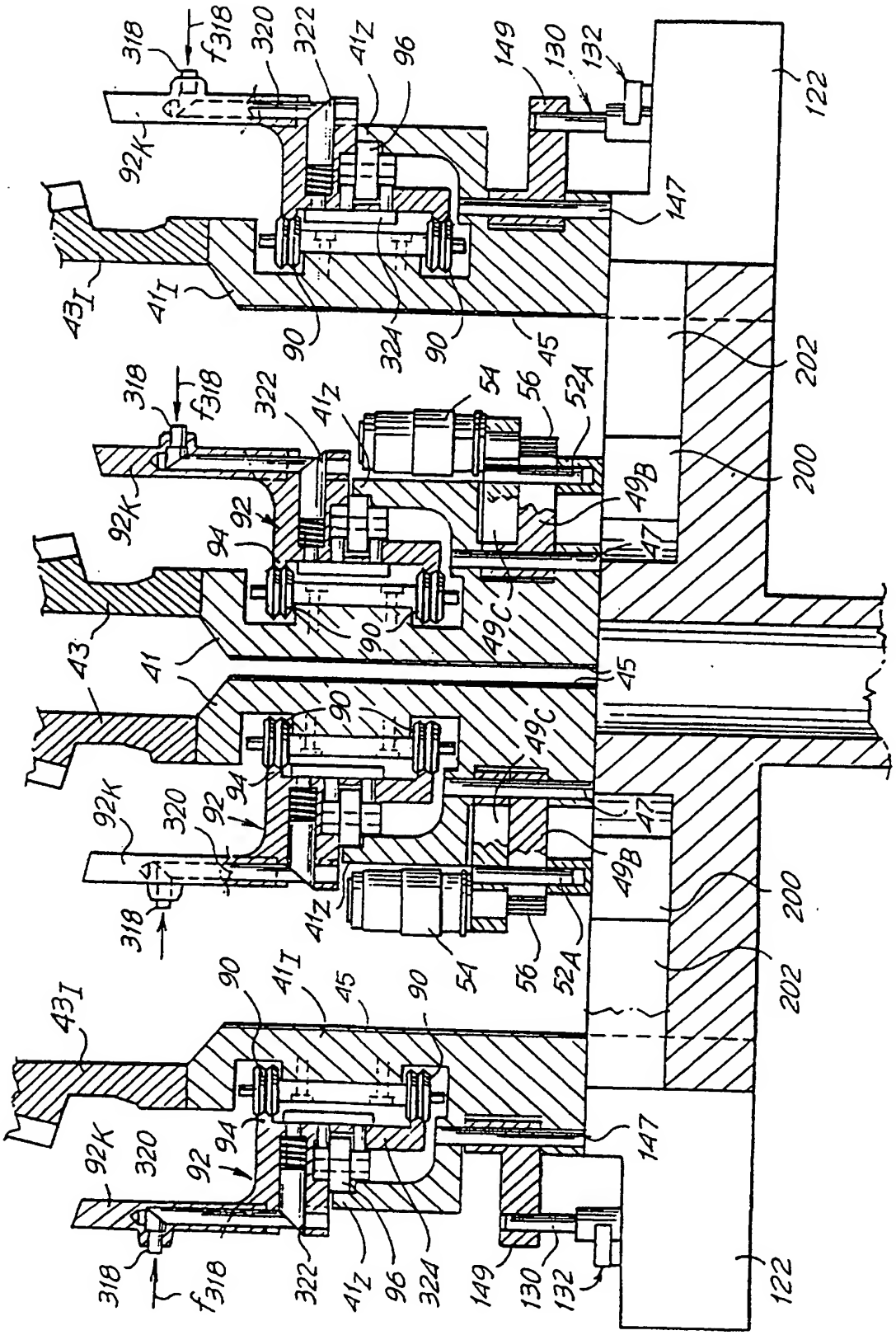
66
60
78
78A

Fig. 23

Fig. 24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52A
49B
200
92
94
43
41
49C
47
318
f318
322
41Z
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52A
49B
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92K
92
94
90
49C
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41
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92K
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47
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52A
202
43I
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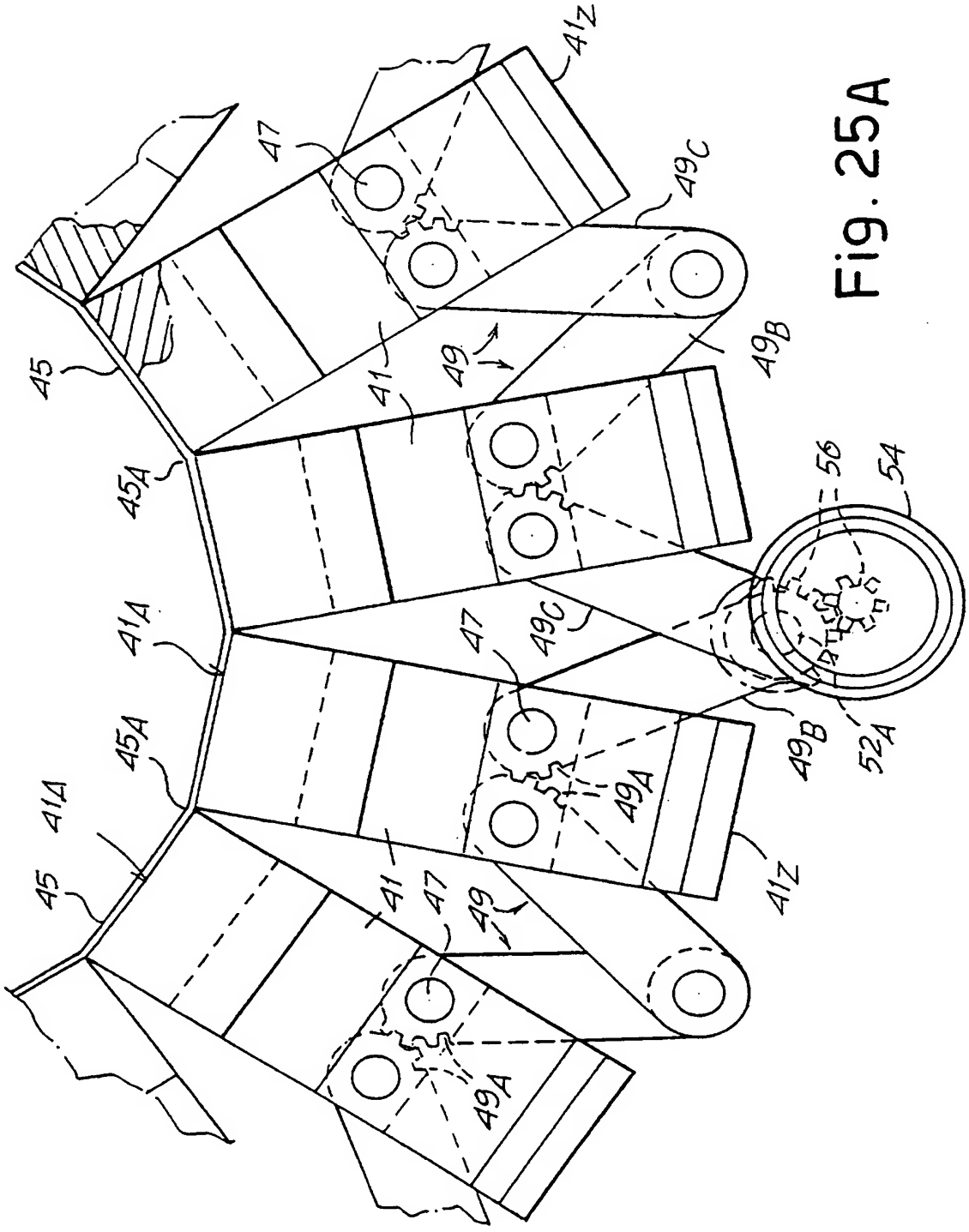
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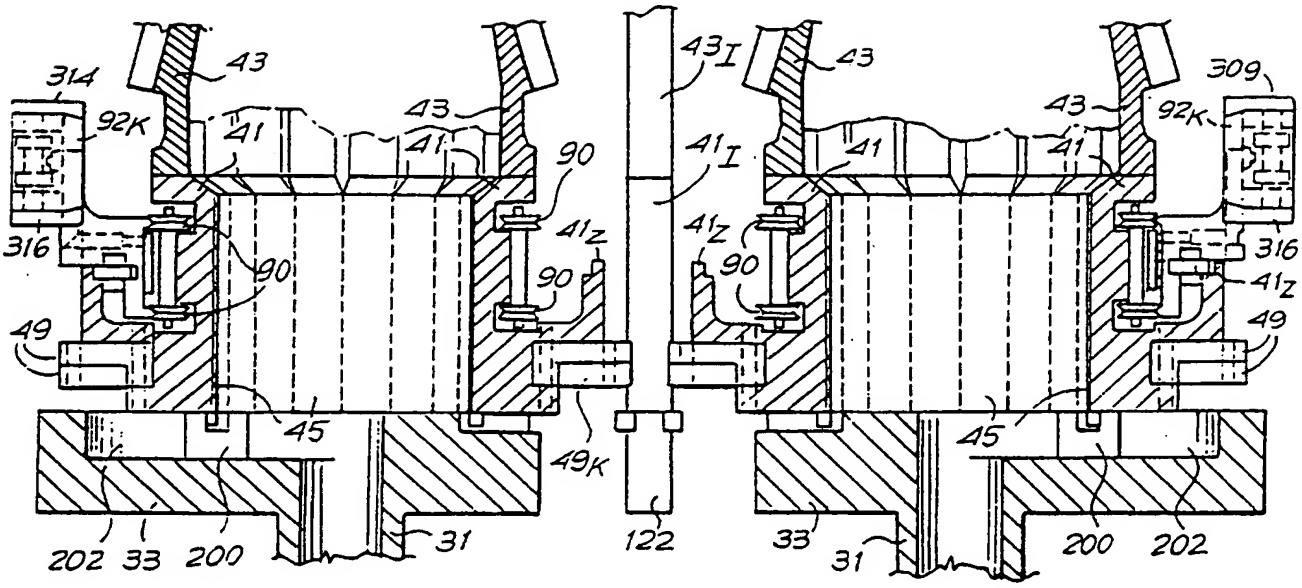
45
41Z
41
47
49
49A

Fig. 25A

Fig. 26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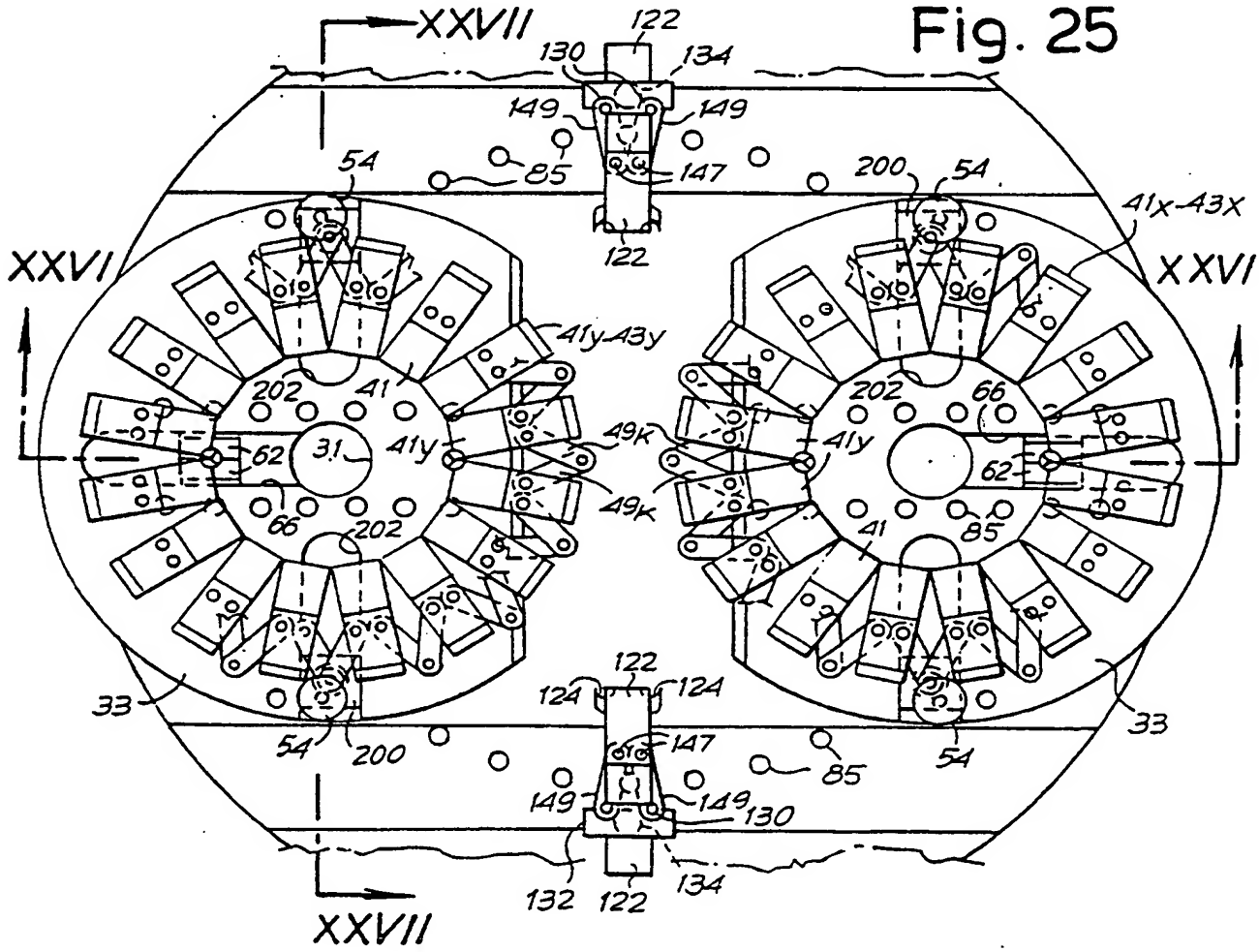
200
202

Fig. 25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XXVI
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62
31
41y
49K
49K
202
66
202
66
41y
62
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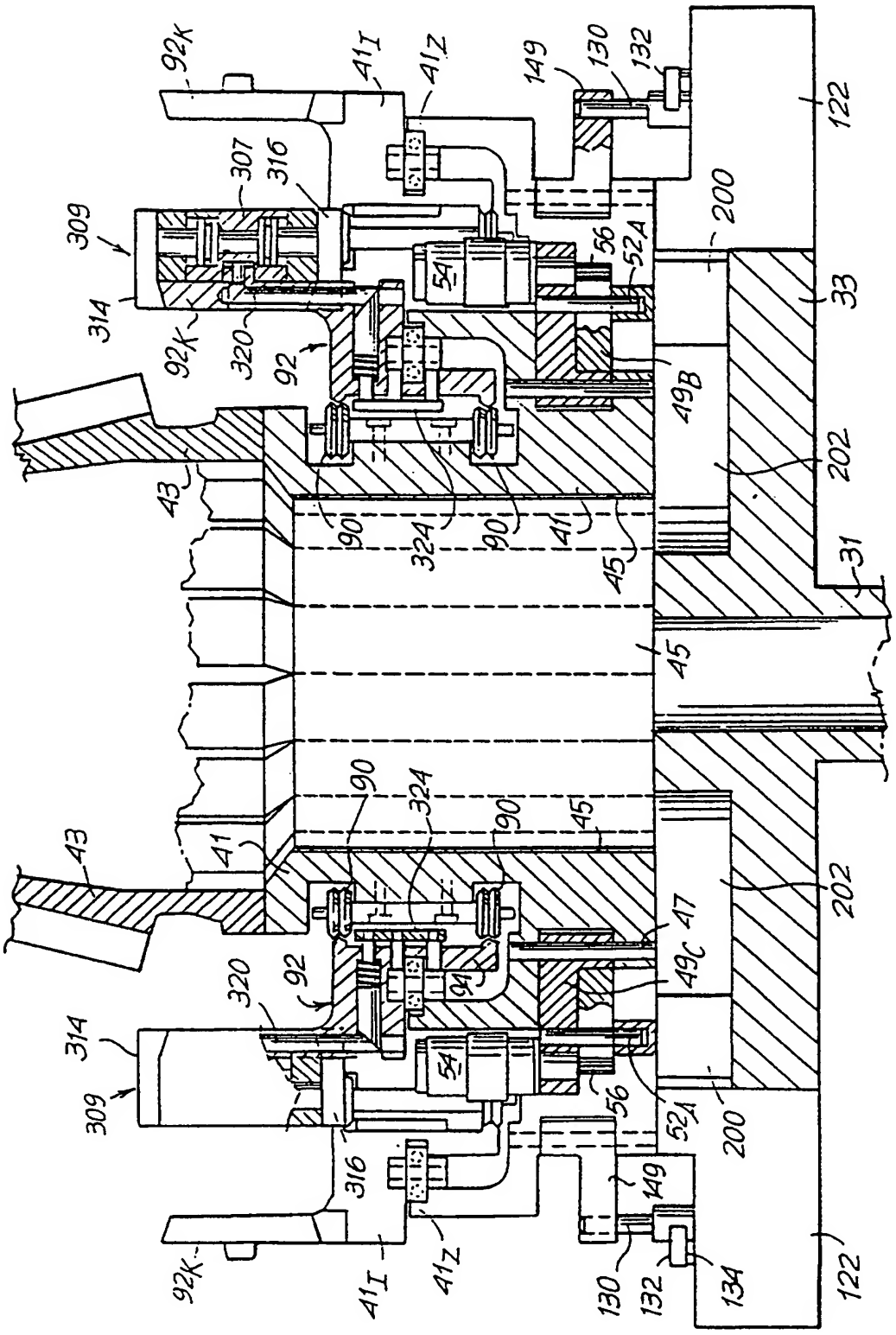
134
XXVII

Fig. 27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49C
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Fig. 29

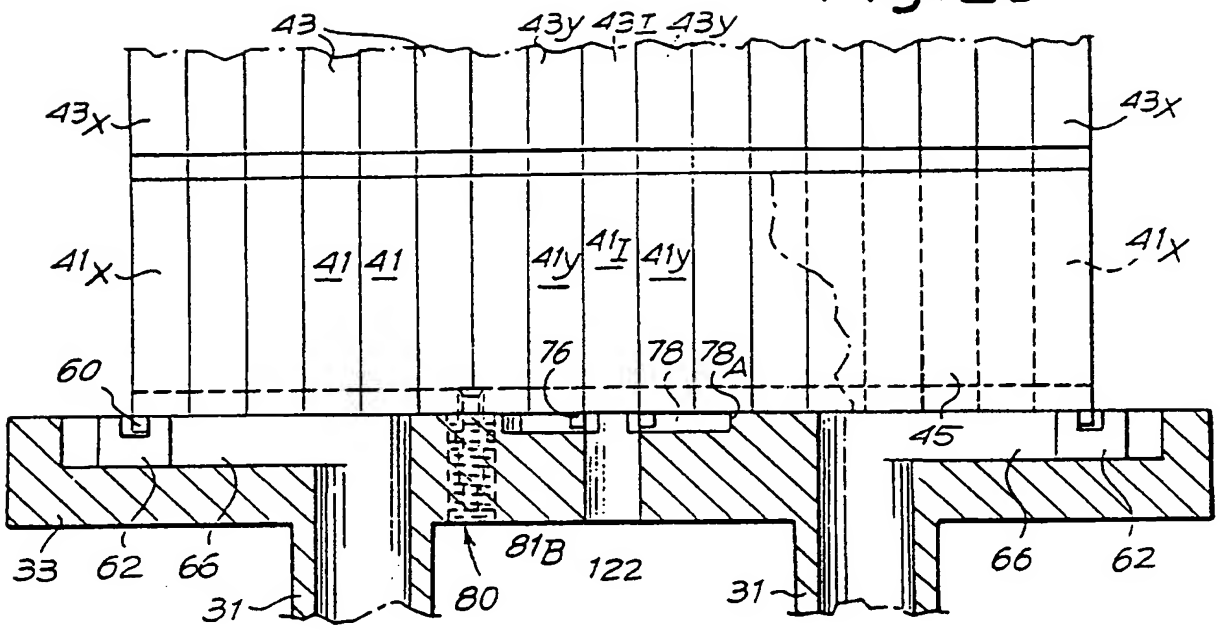
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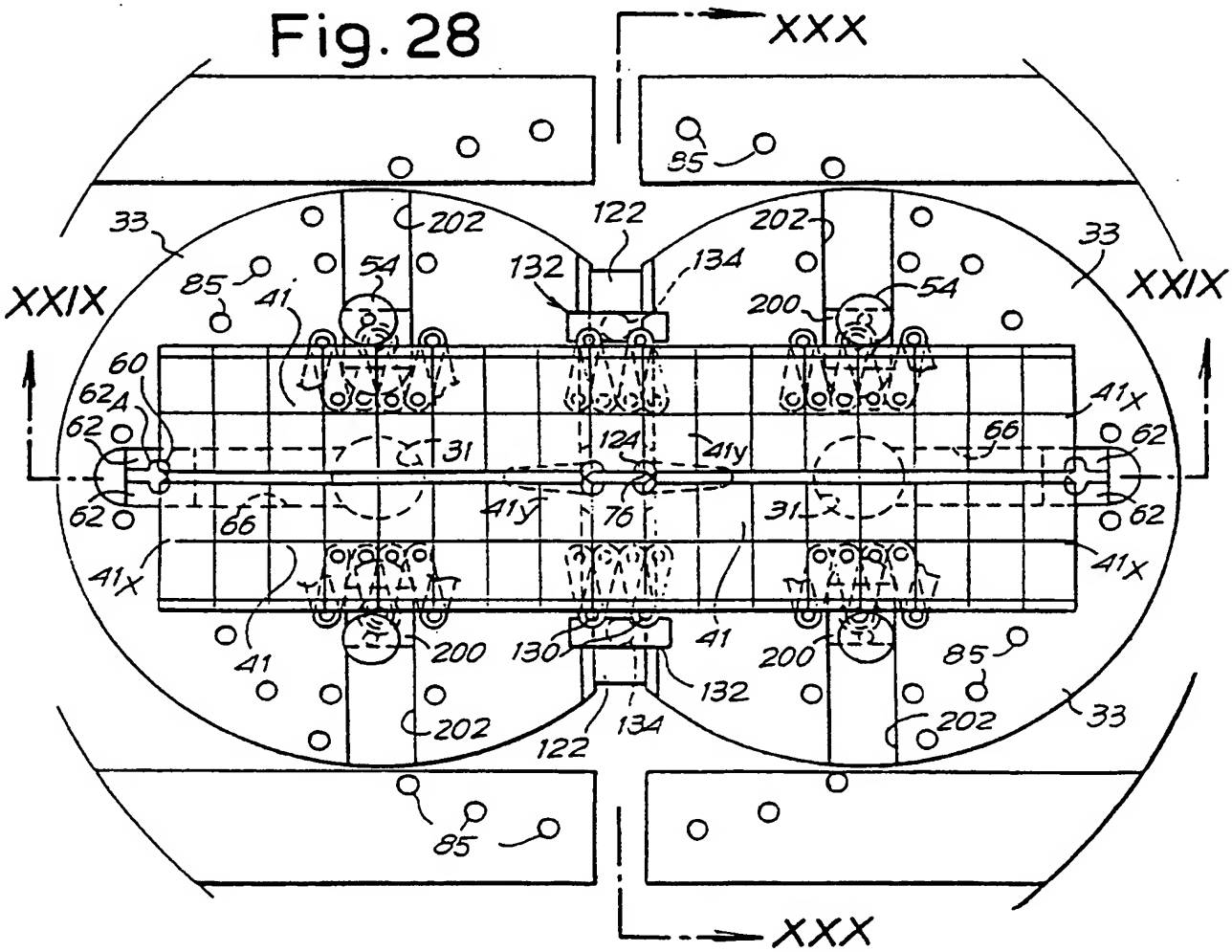
Fig. 28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41y
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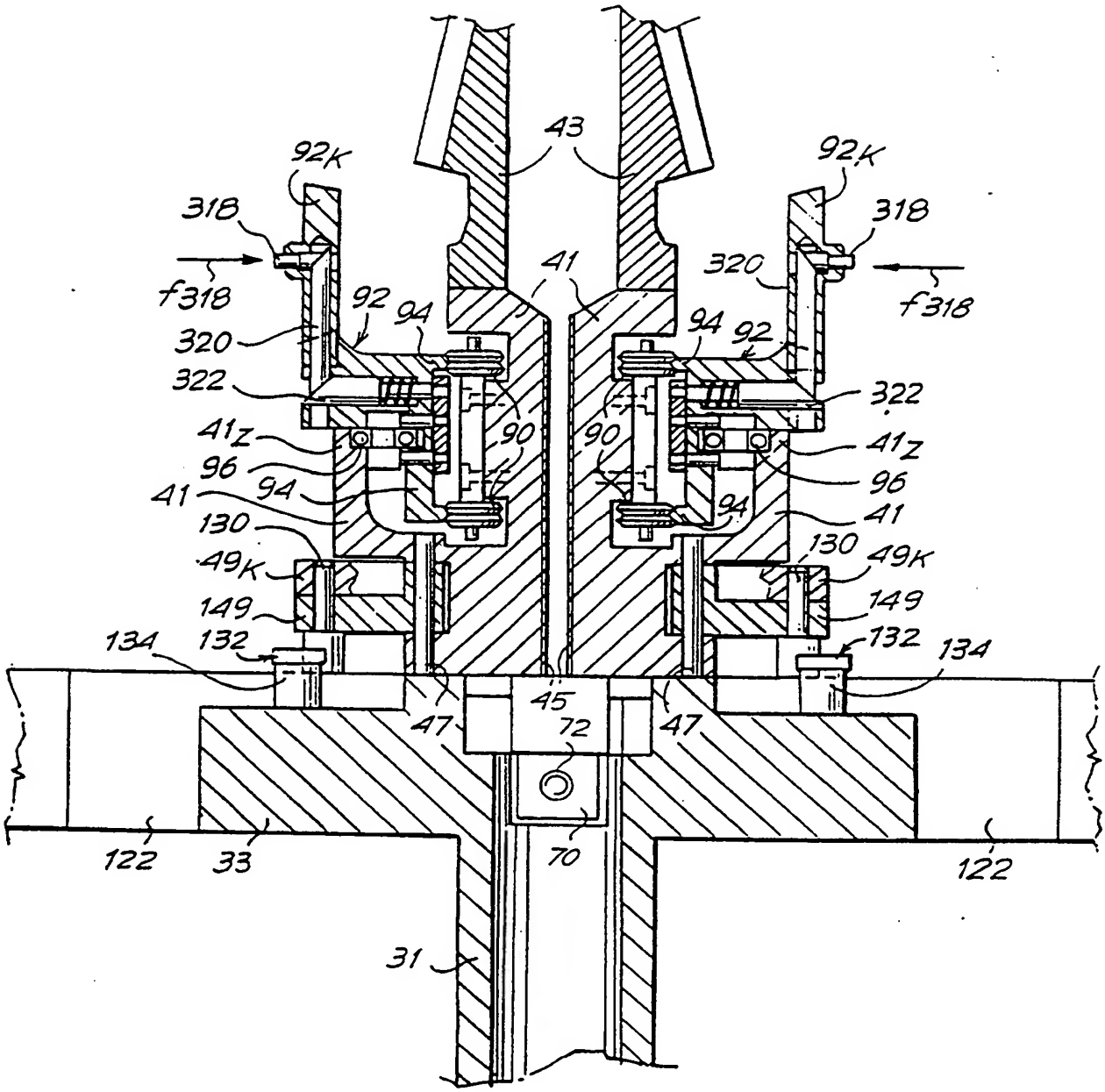
Fig.30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31

Fig 32

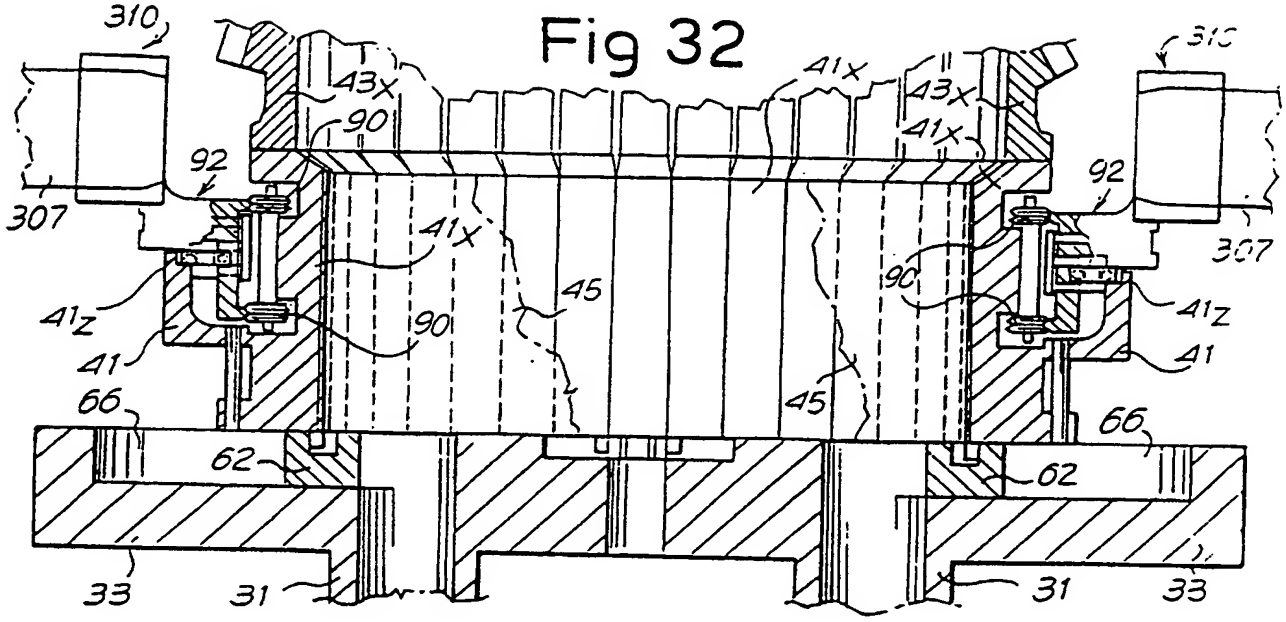
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Fig. 31

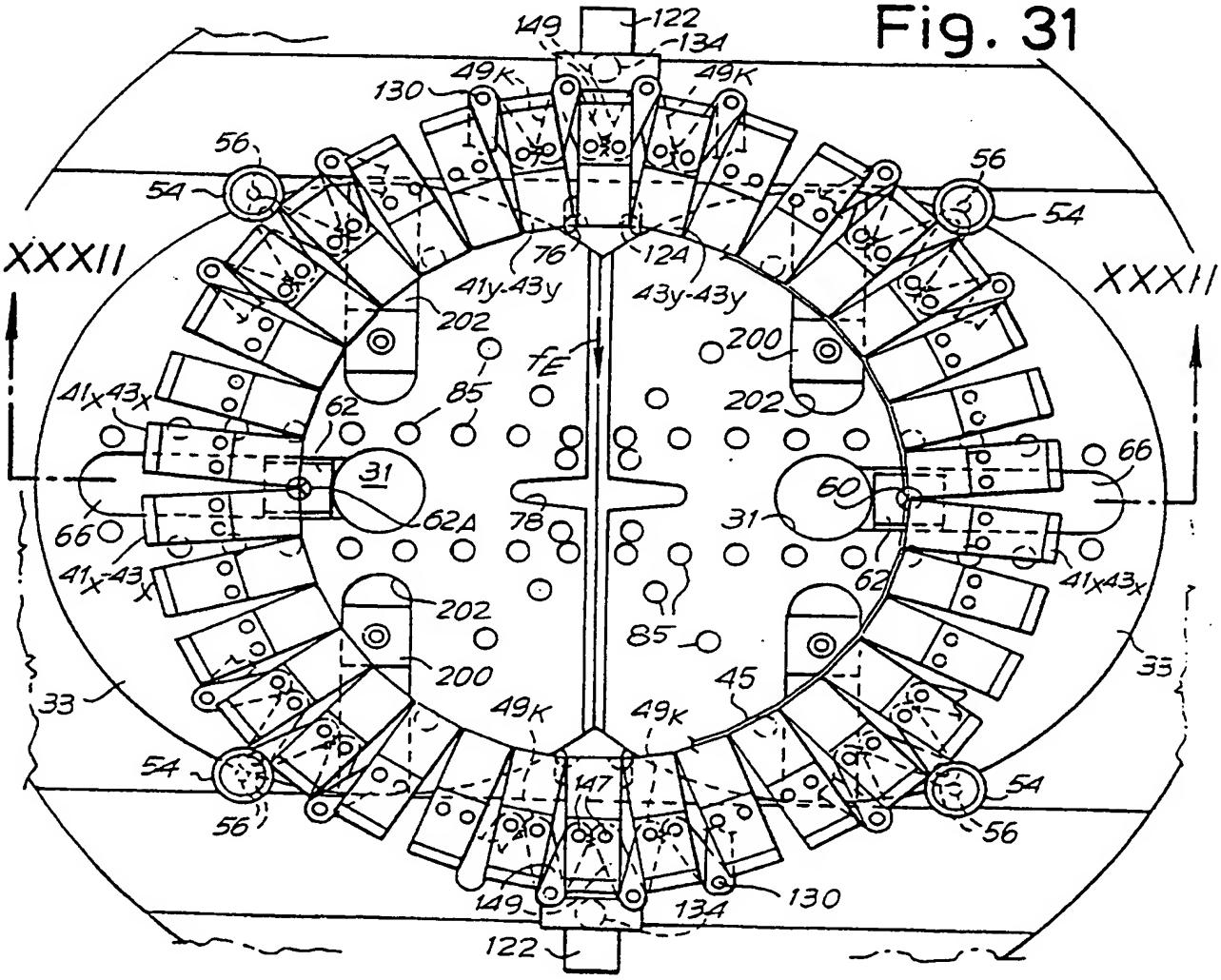
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Fig. 33

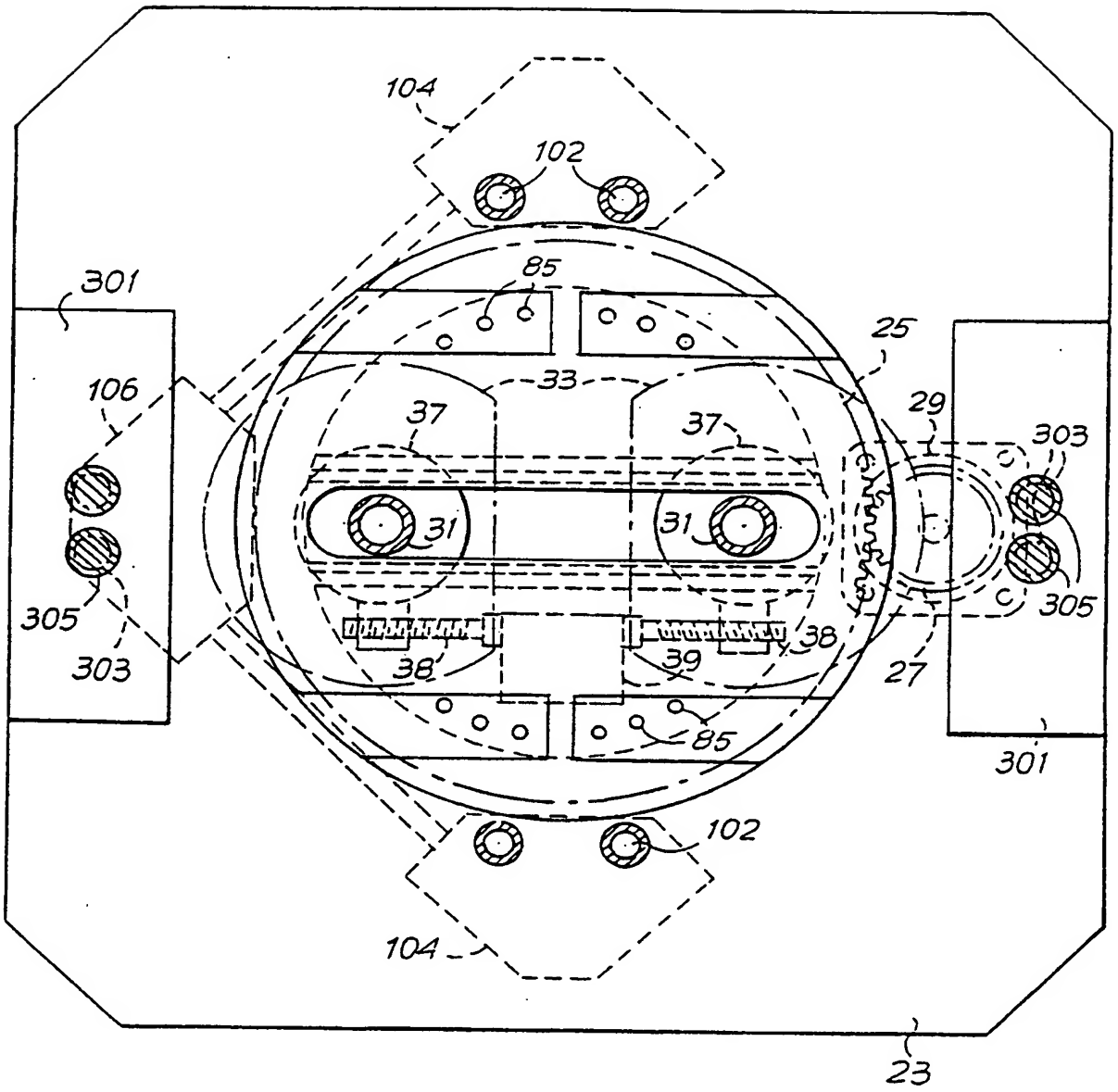
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Fig. 34

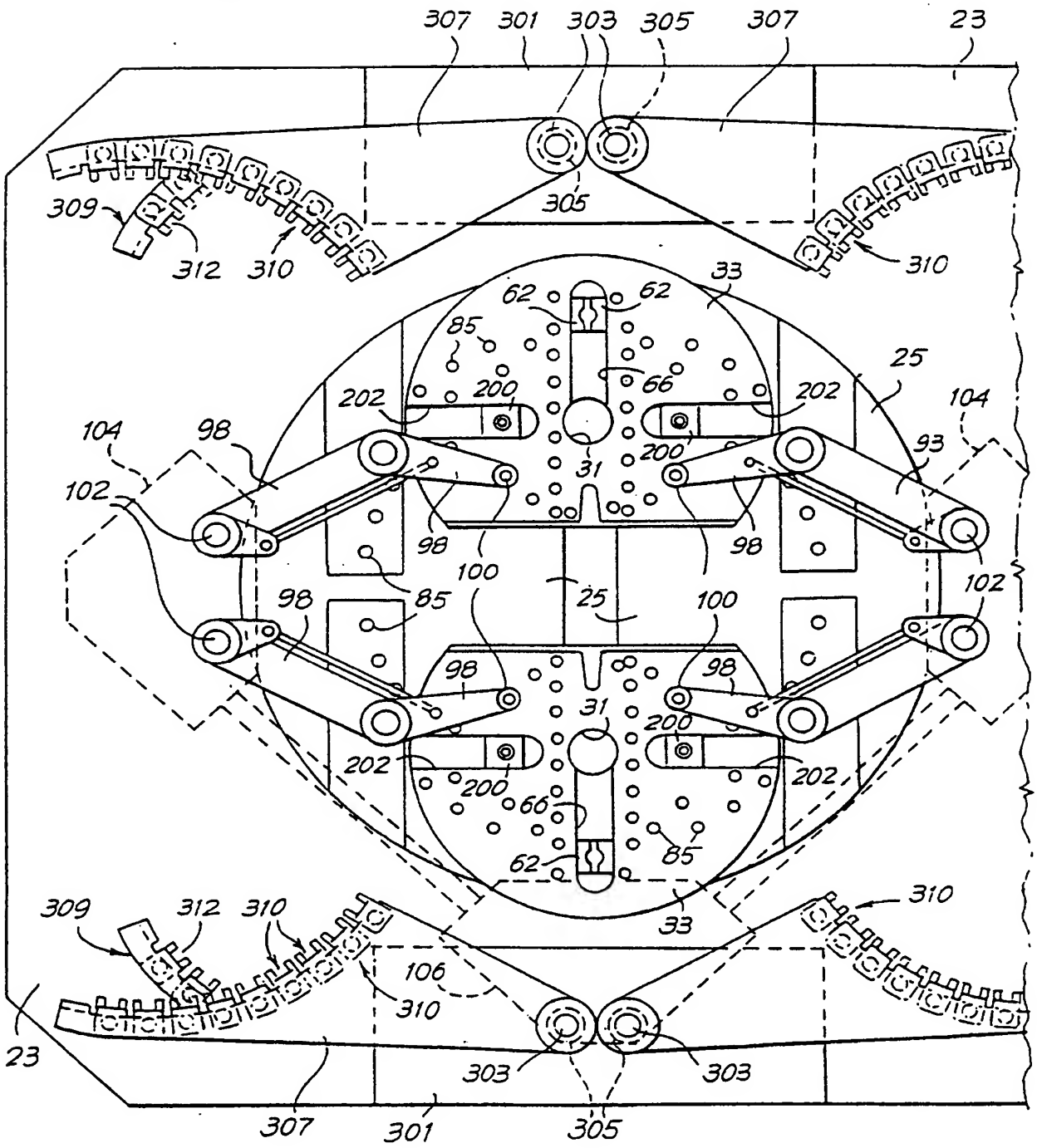
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Fig. 35

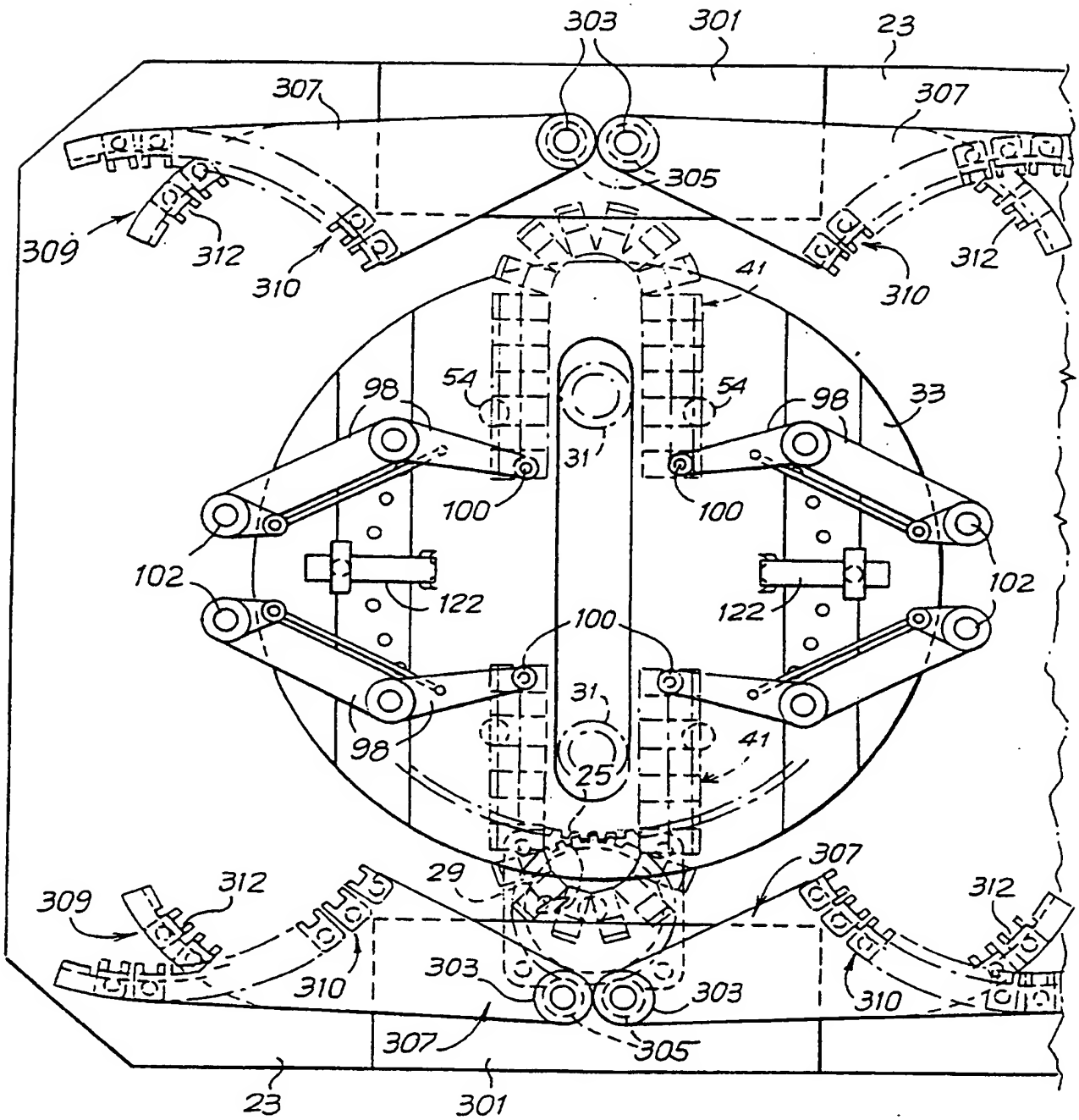
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Fig. 36

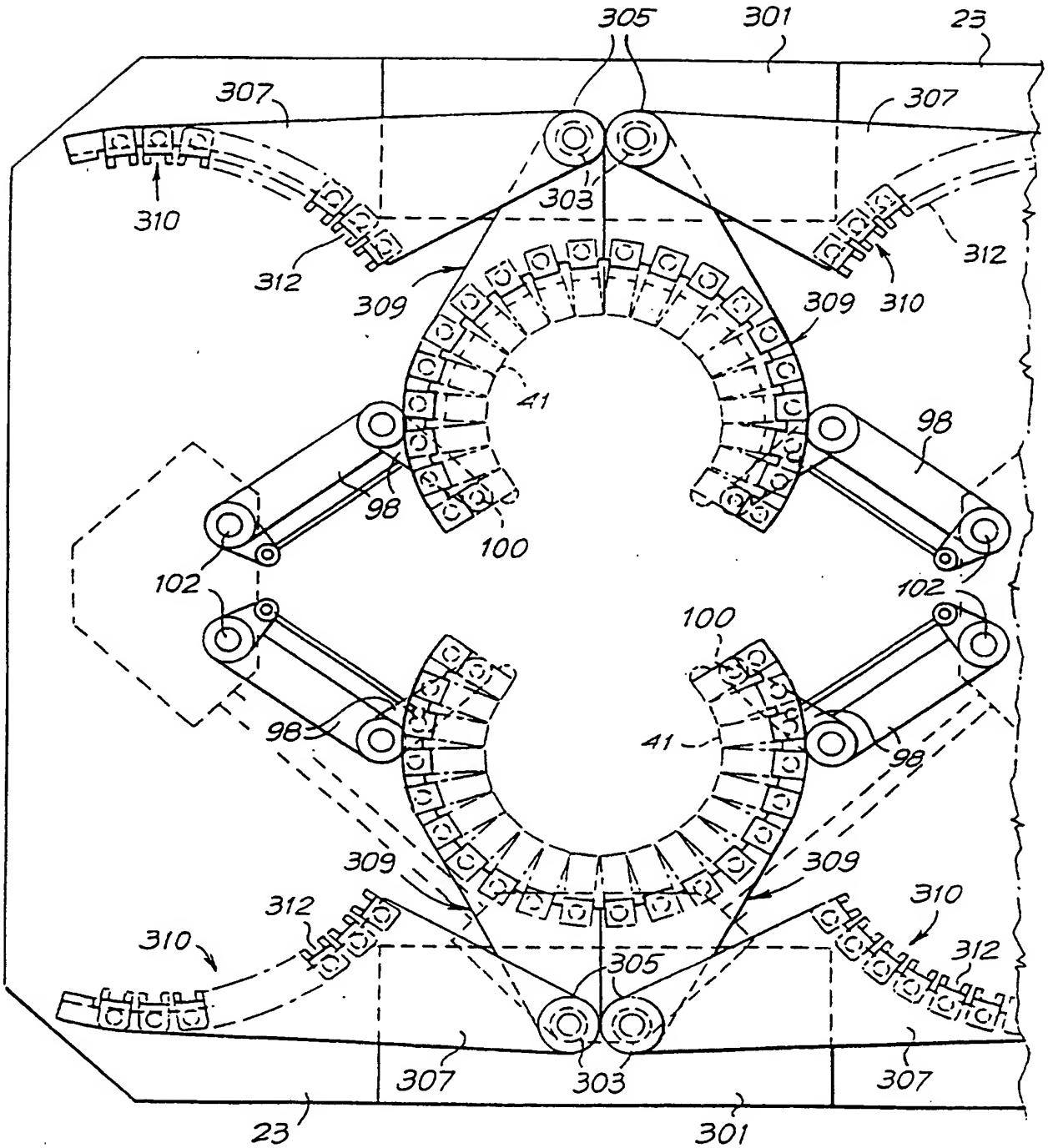
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Fig. 37

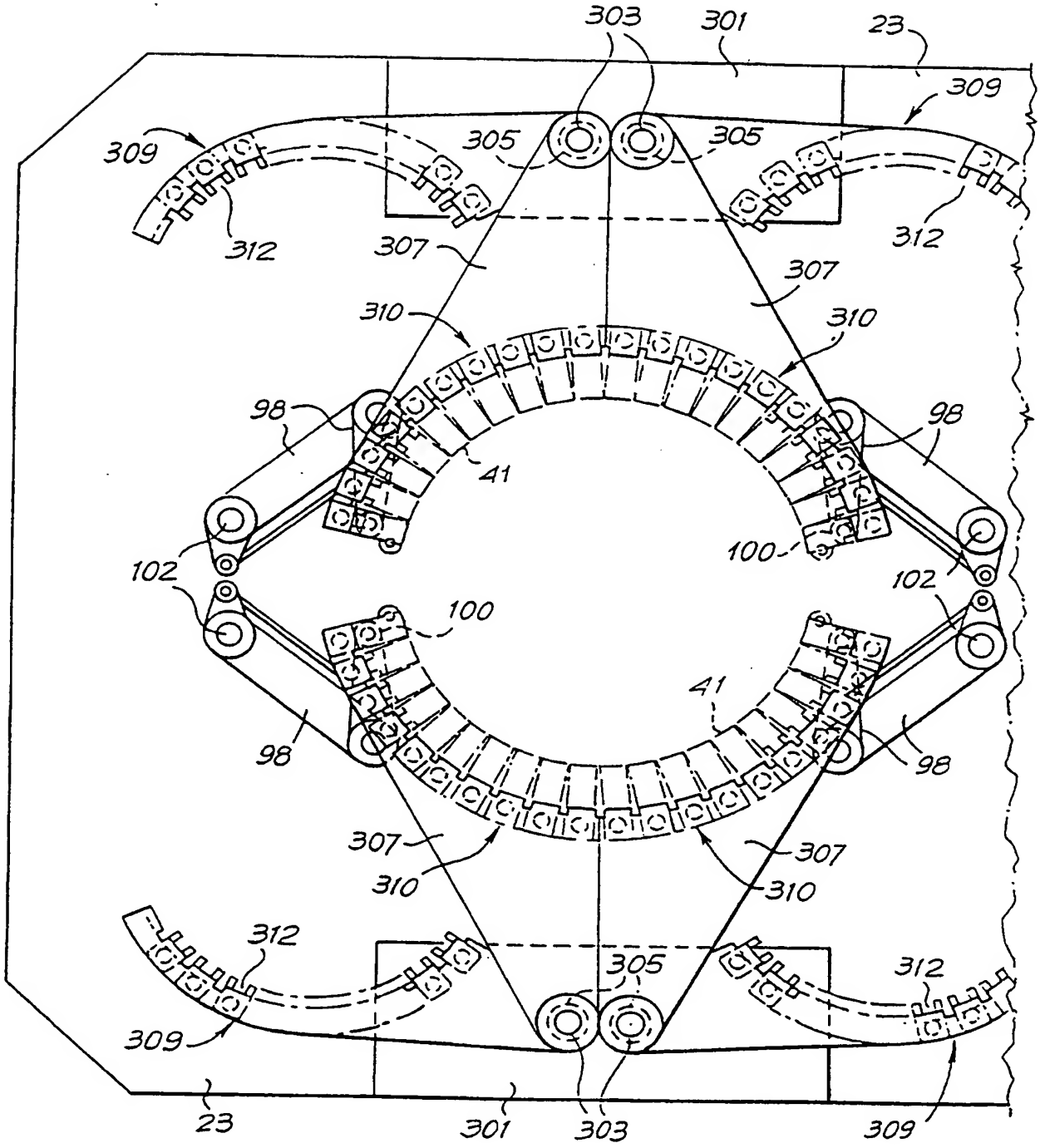
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Fig. 38

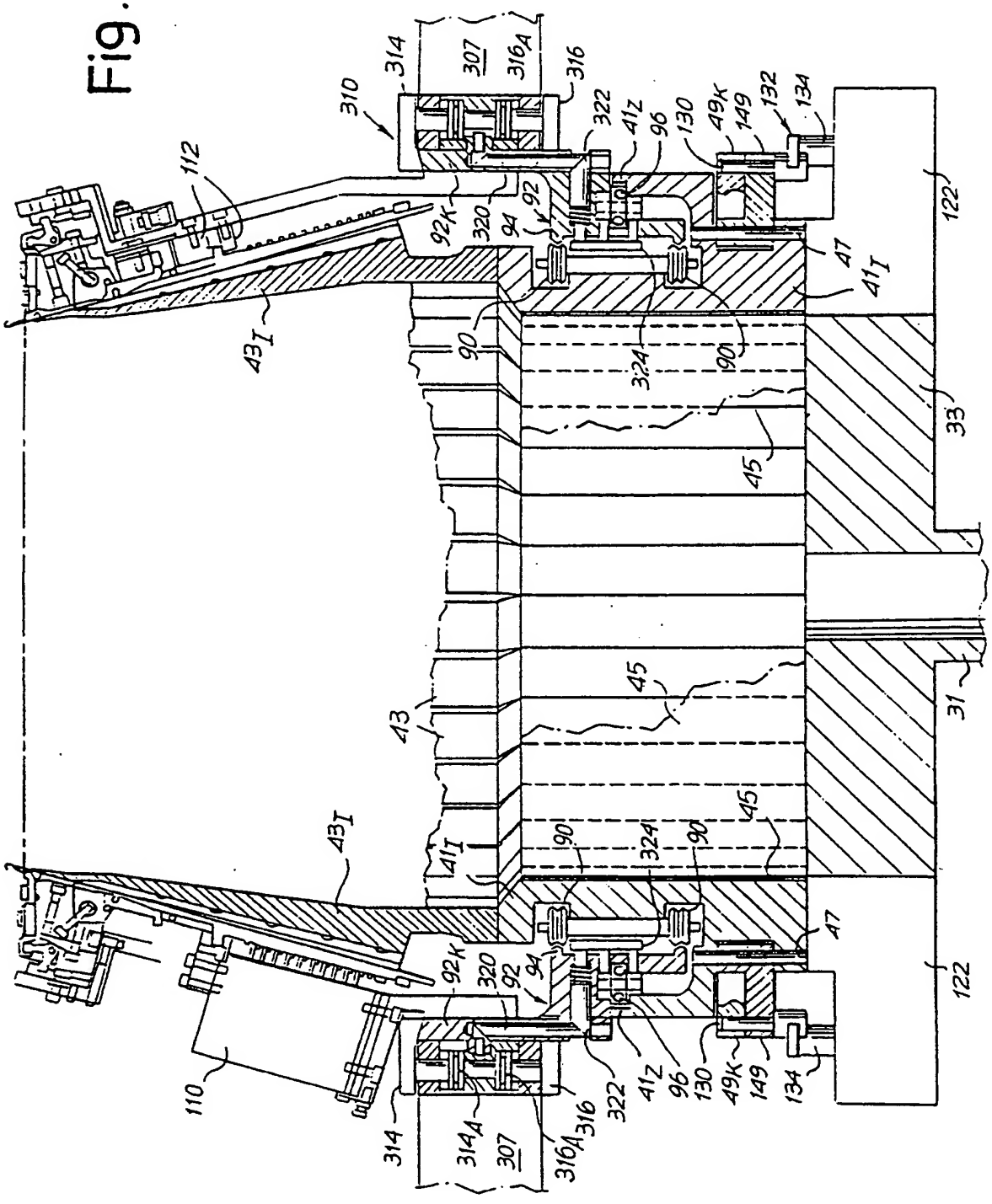
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Fig. 39

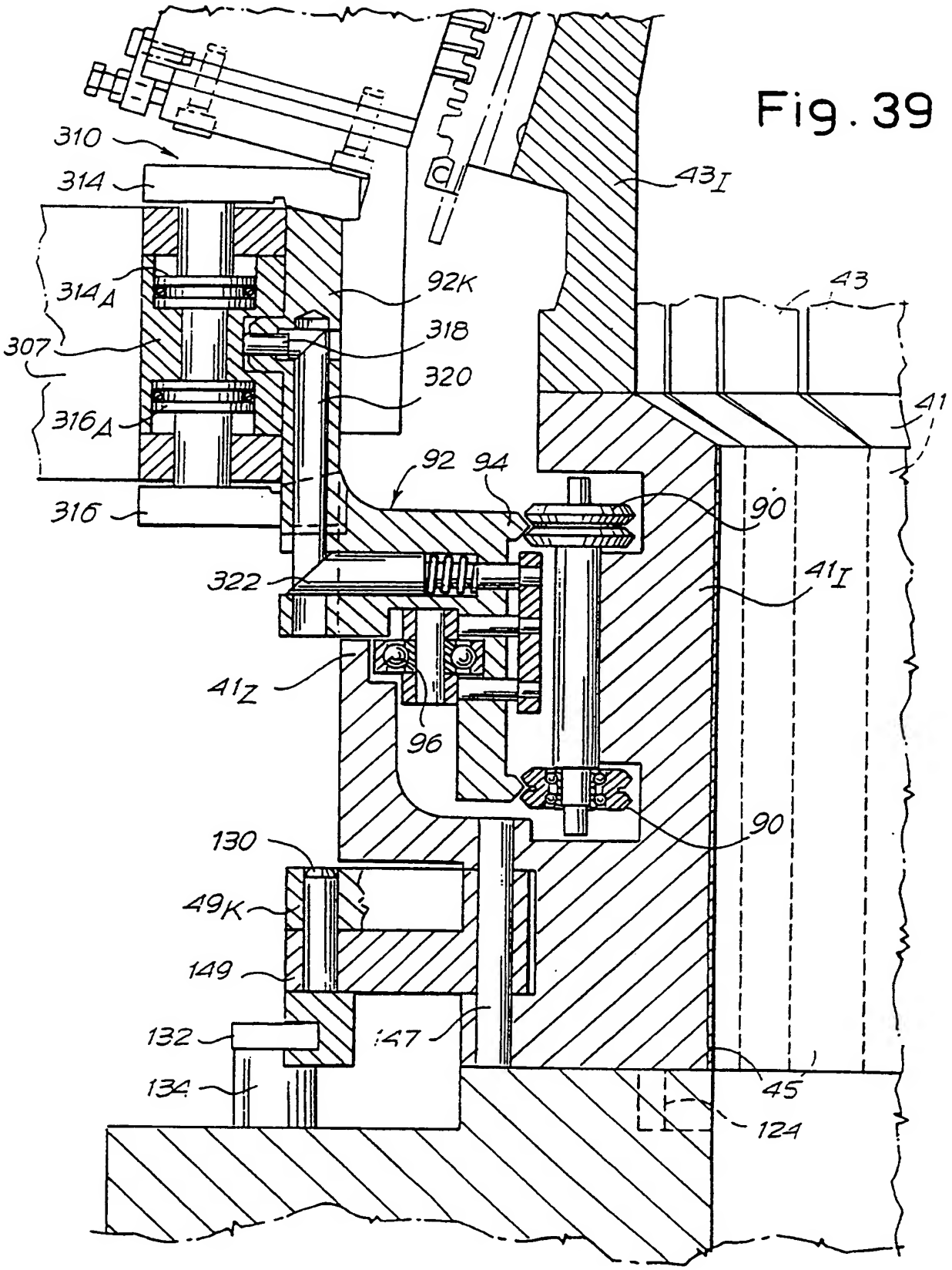
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Fig. 42

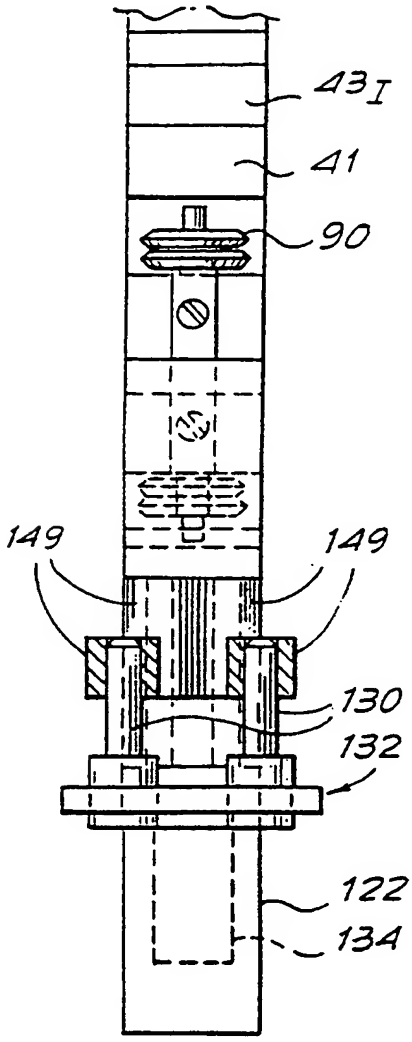


Fig. 40

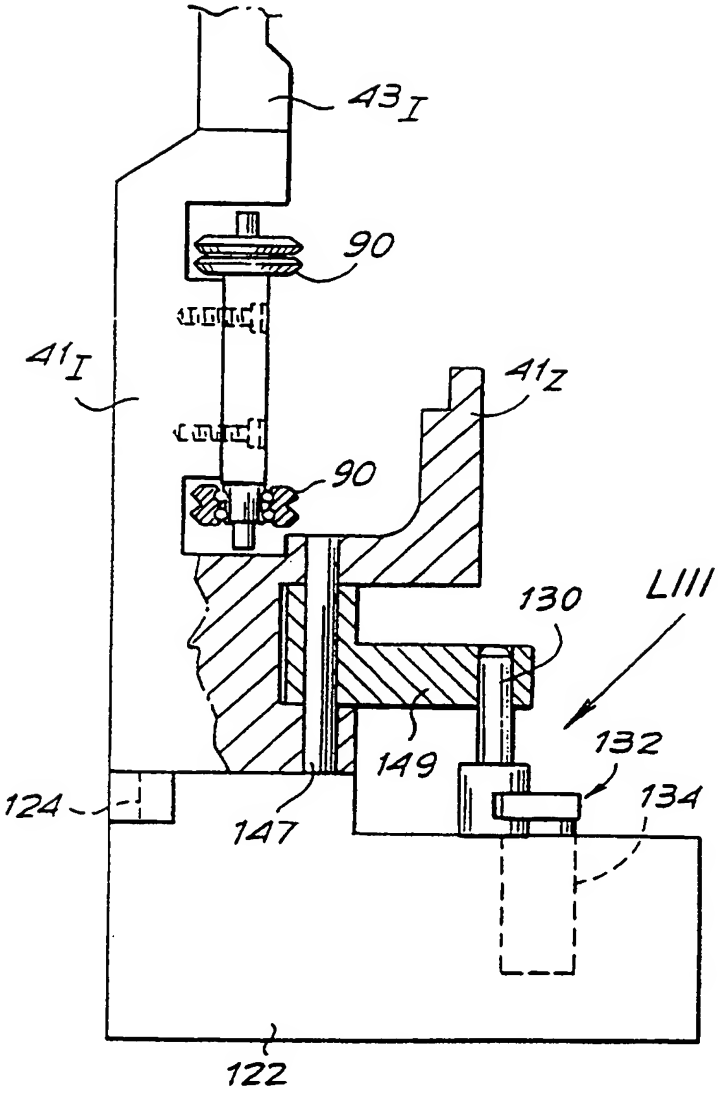


Fig. 41

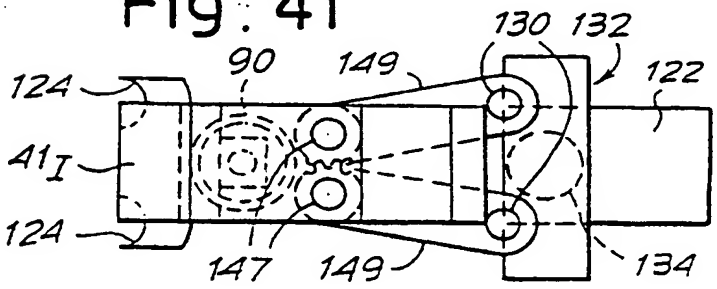
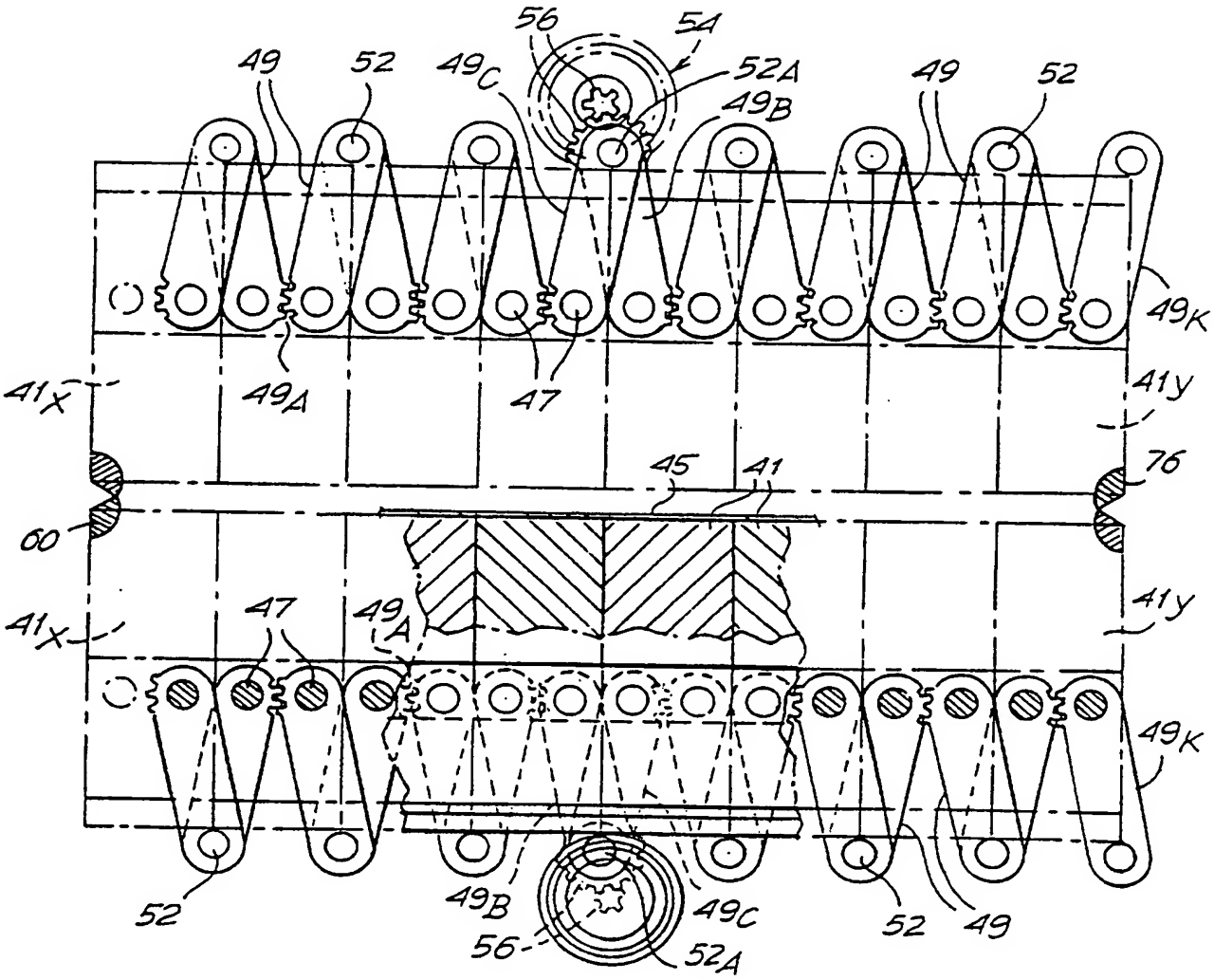


Fig. 43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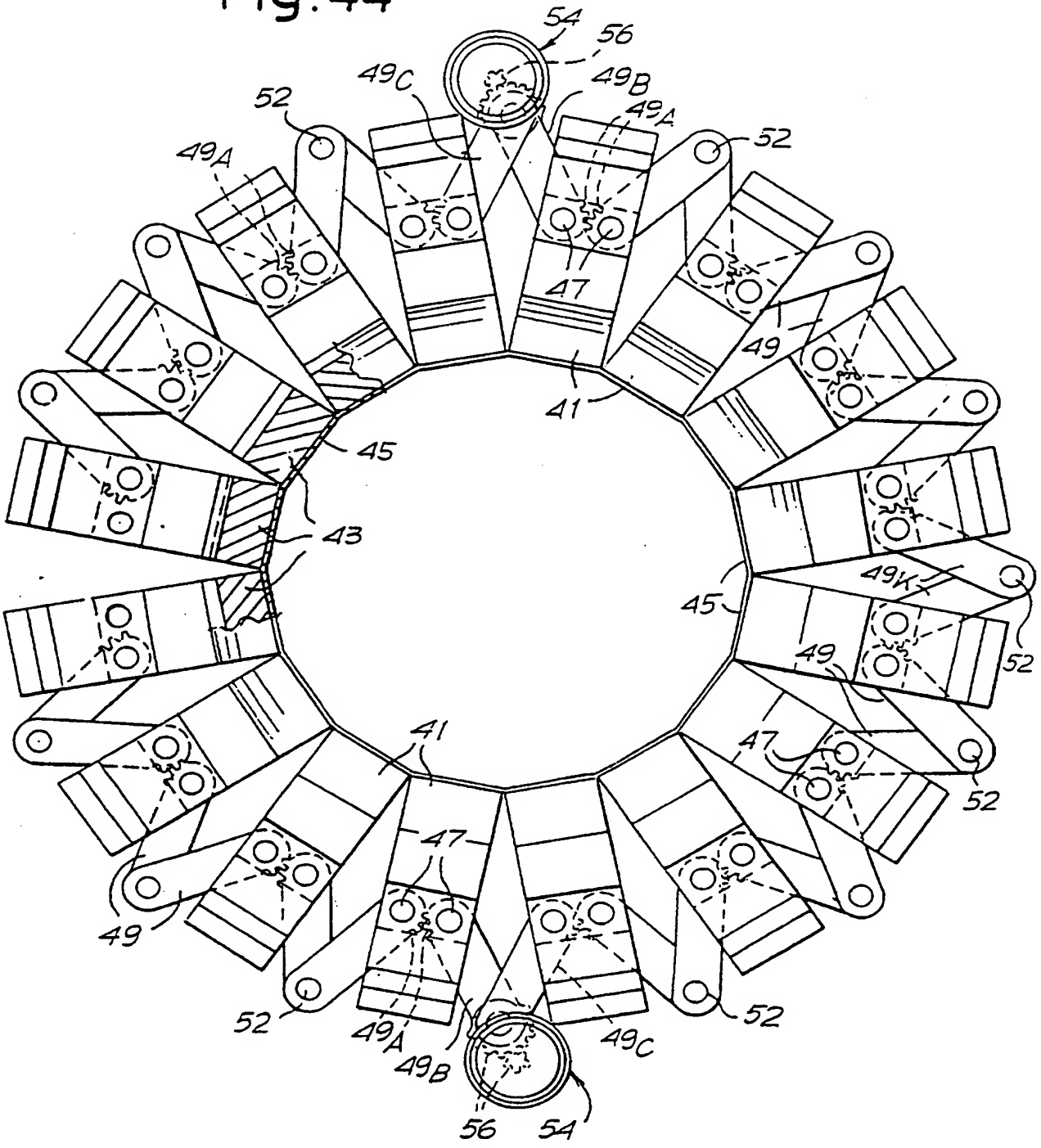
52A

Fig.44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49A
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49C
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56
54

Fig. 45

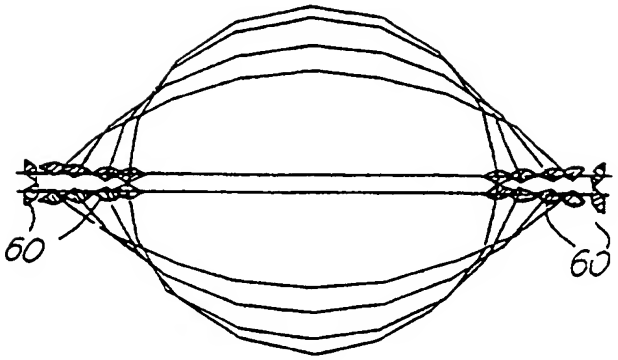


Fig. 48

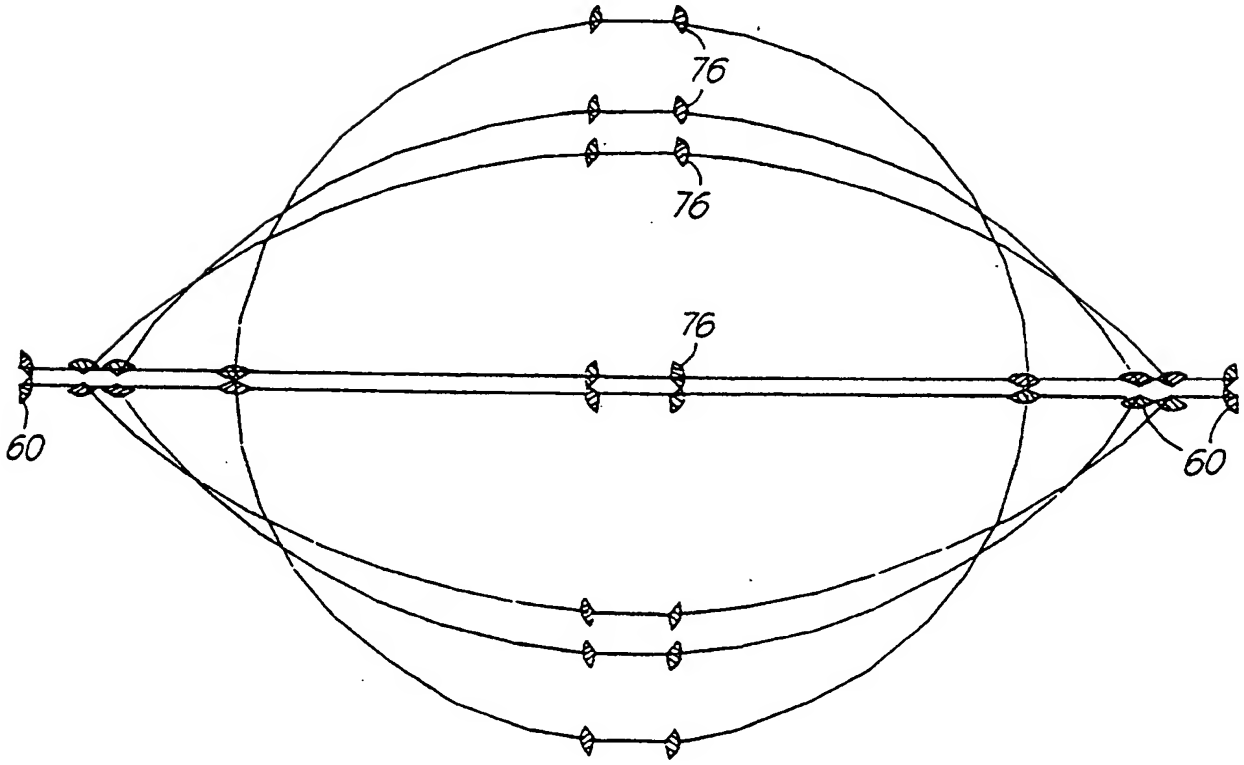


Fig. 46

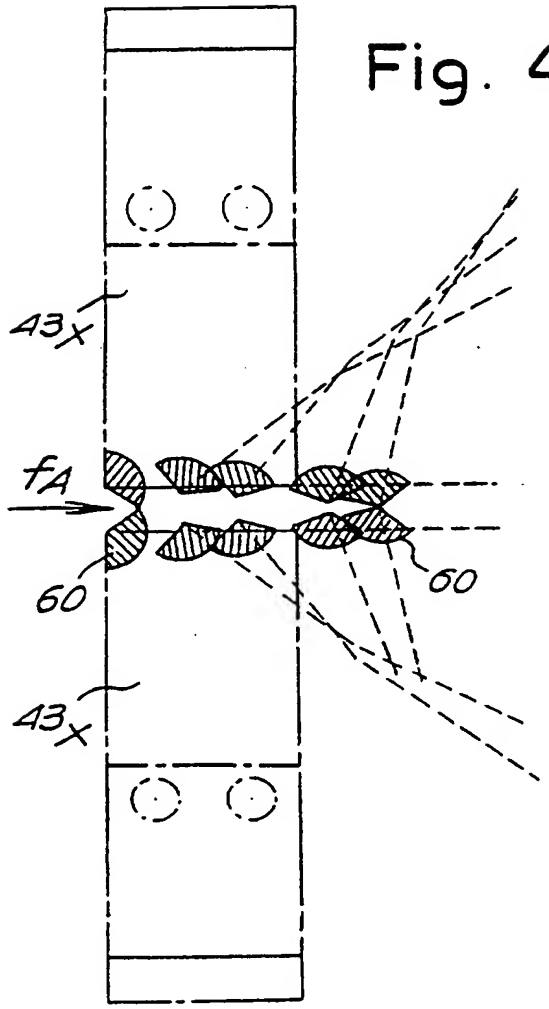


Fig. 47

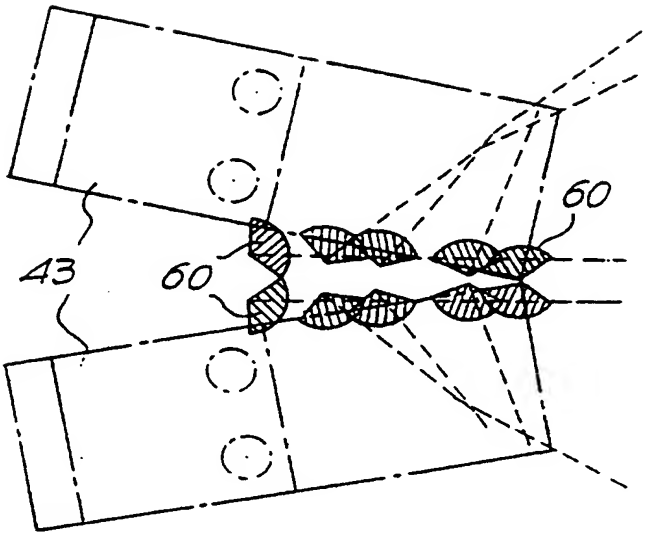
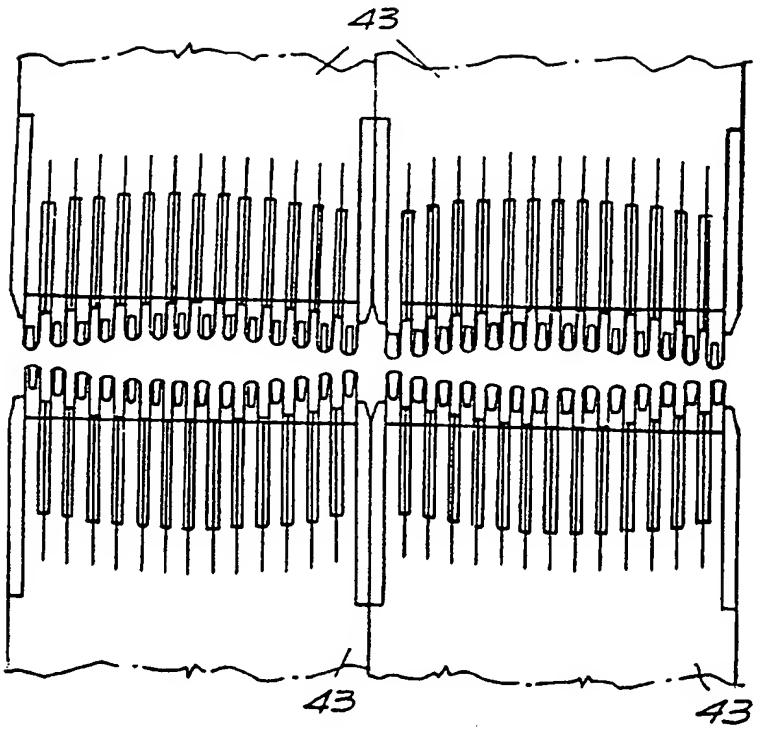


Fig.49



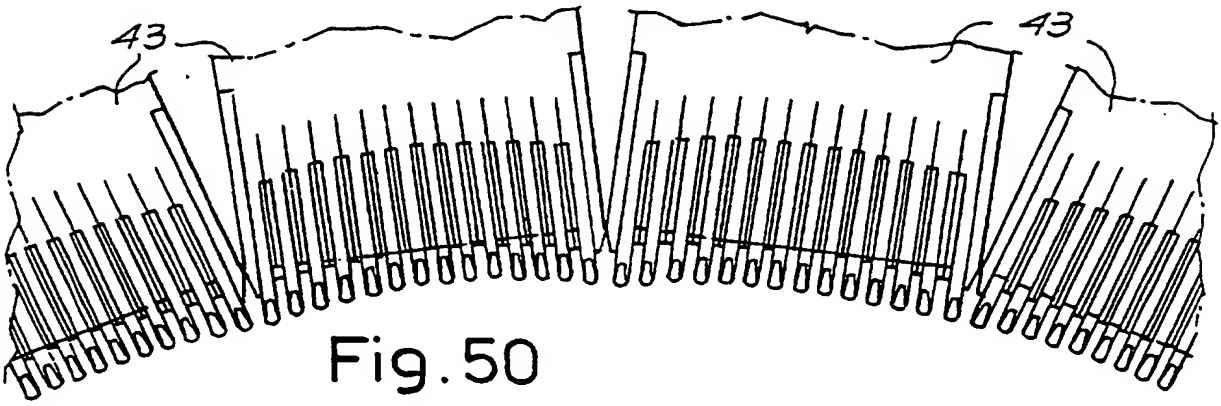
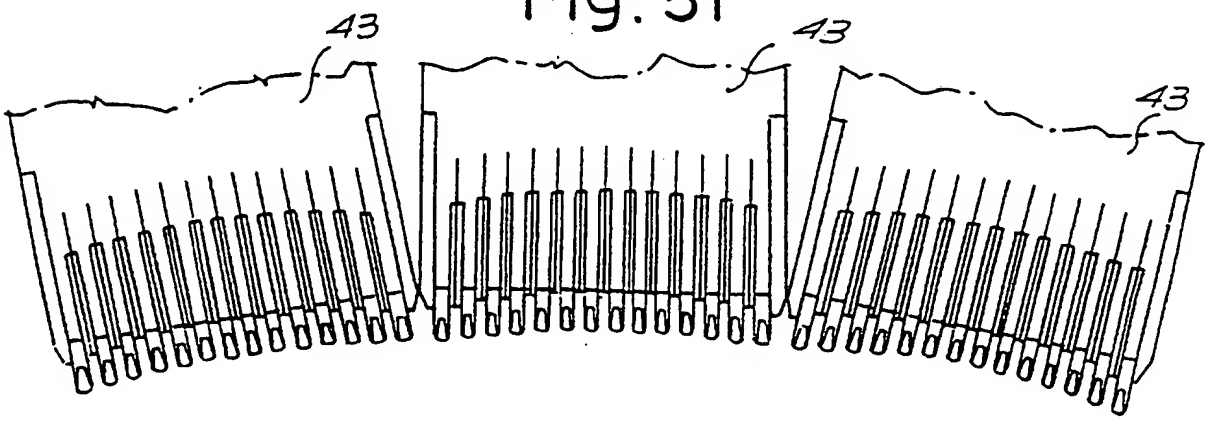


Fig.50

Fig.51



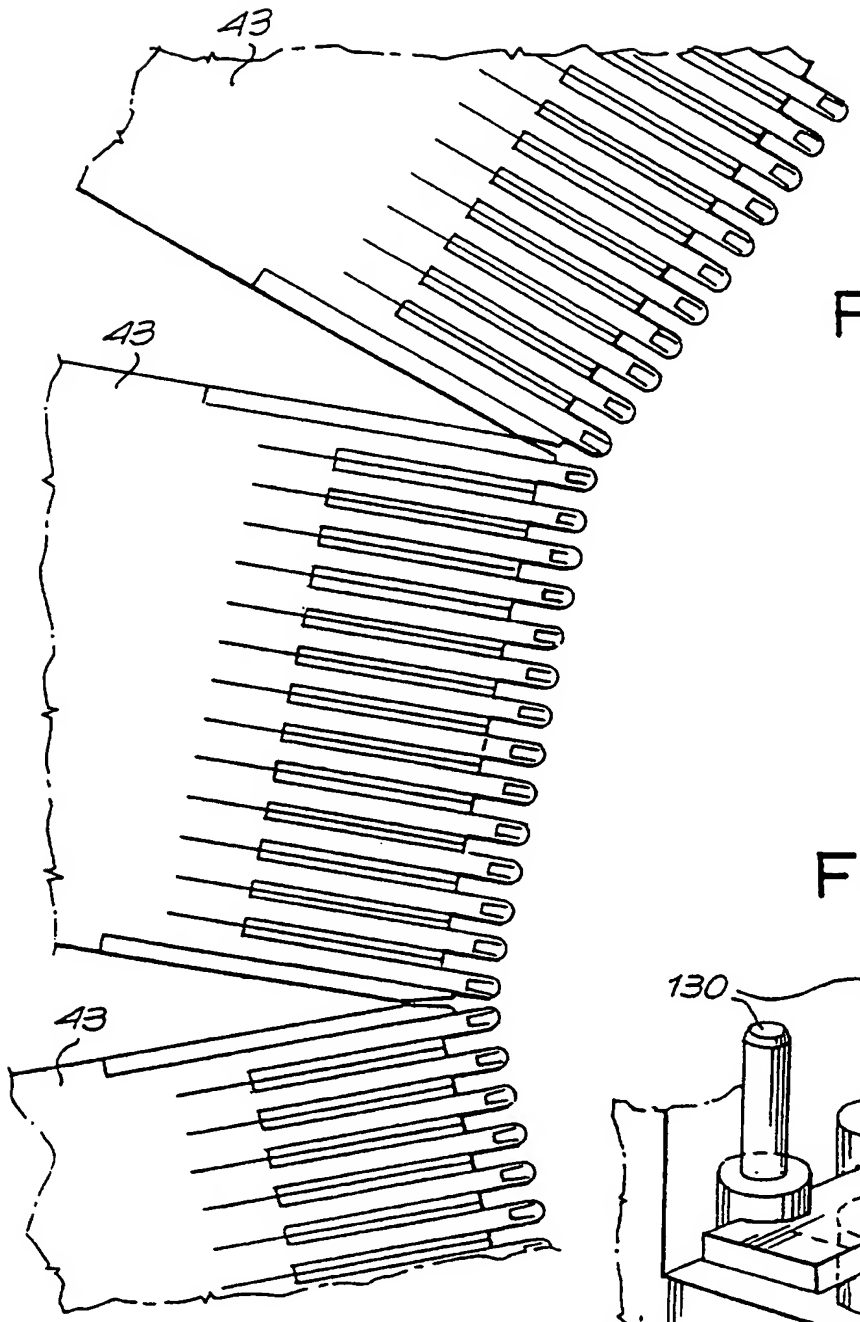


Fig. 52

Fig. 53

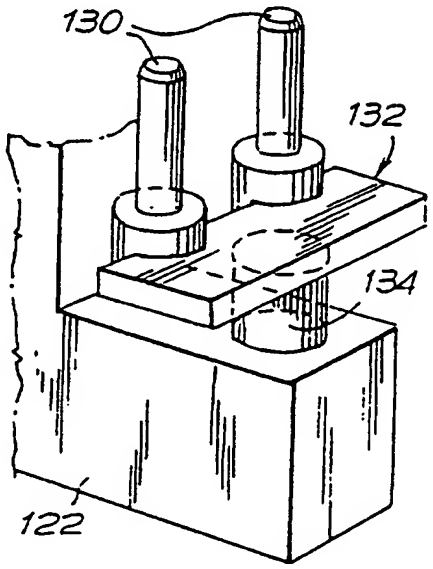


Fig. 54

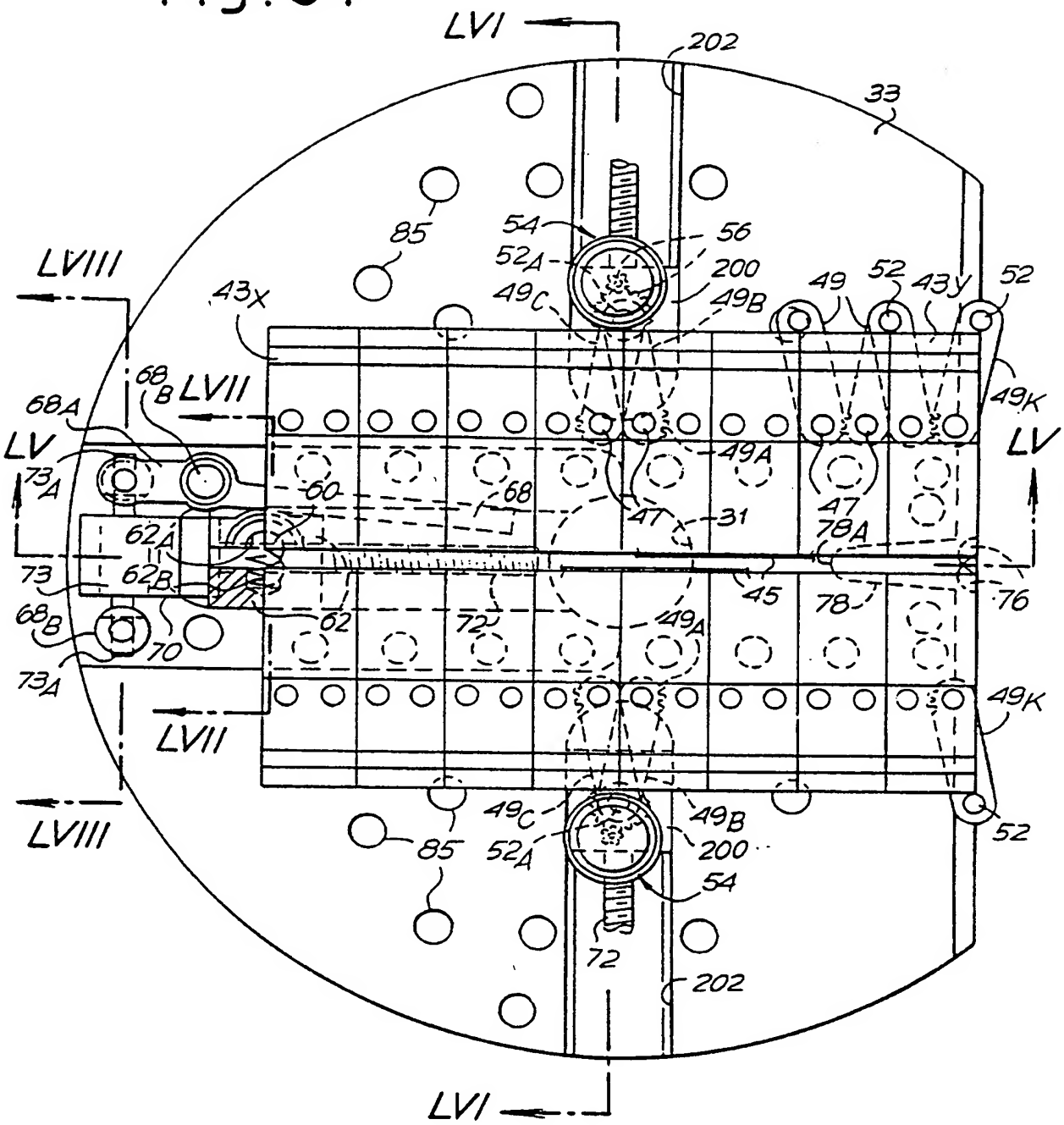

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Fig.55

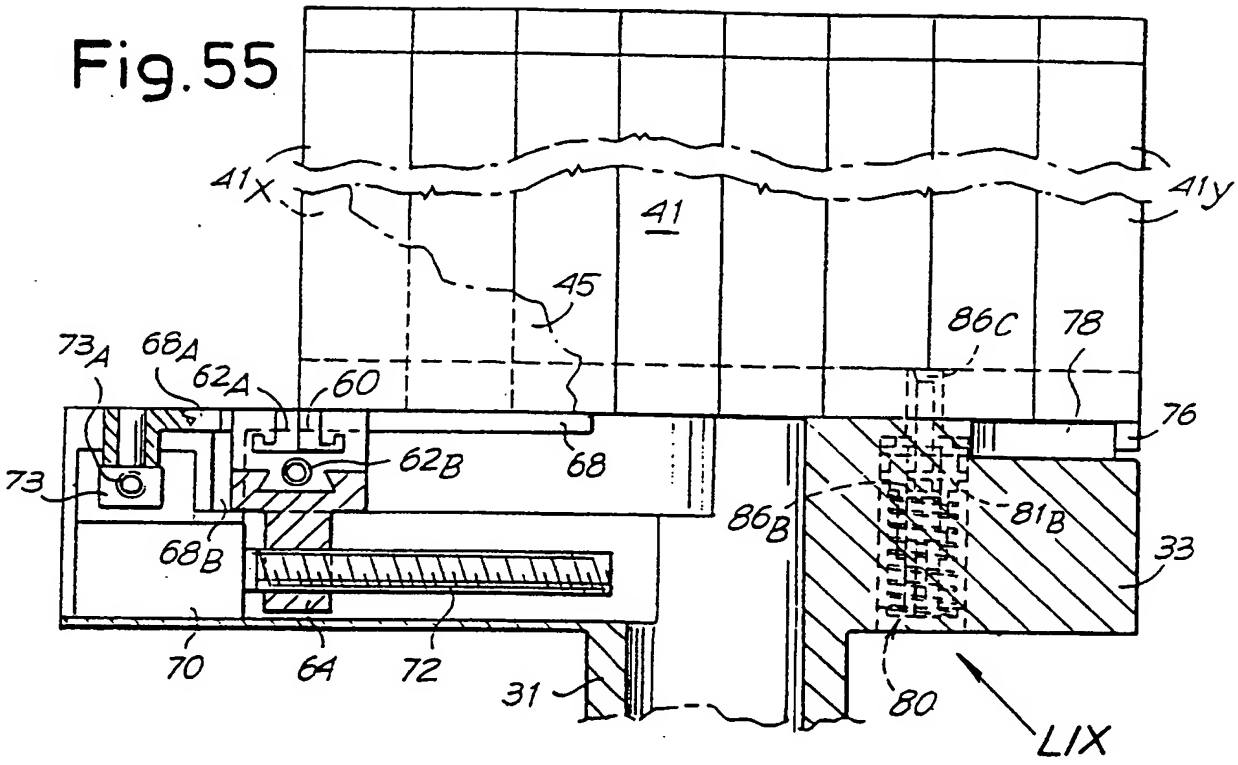
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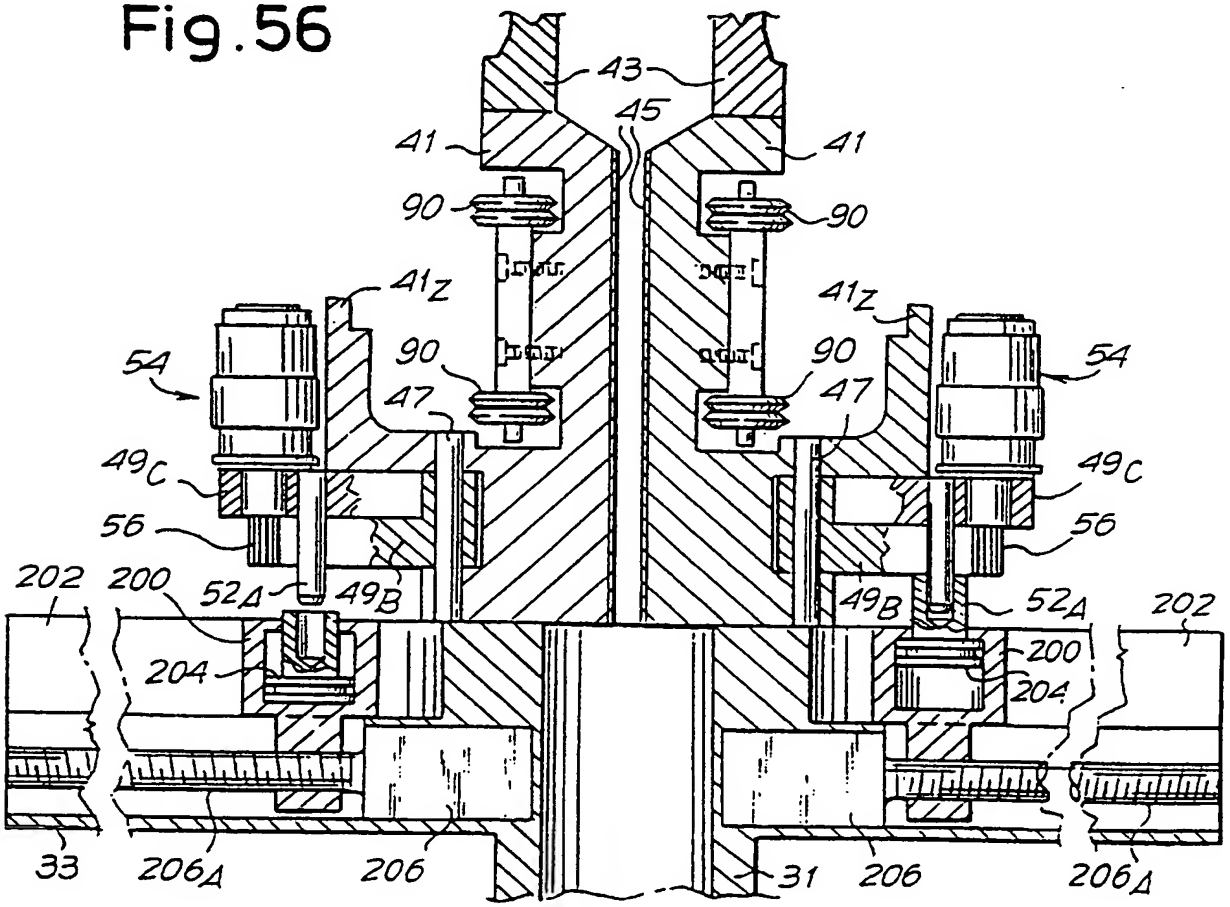
Fig.56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206A

Fig.57

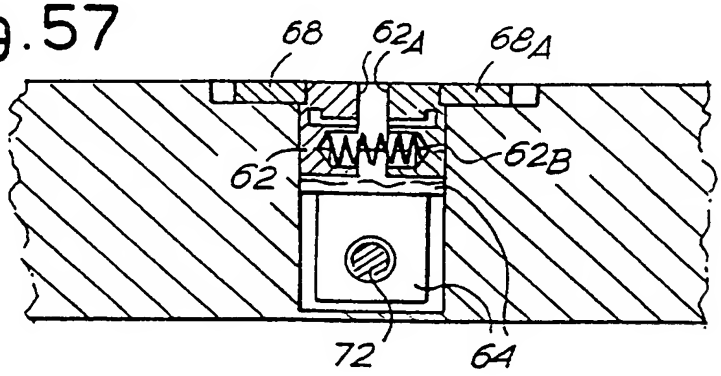

Fig.58

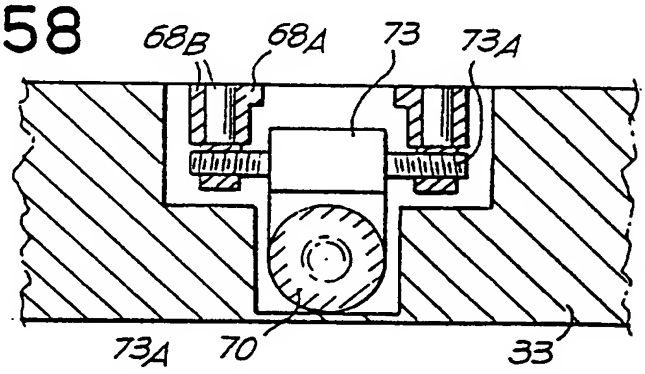

Fig.59

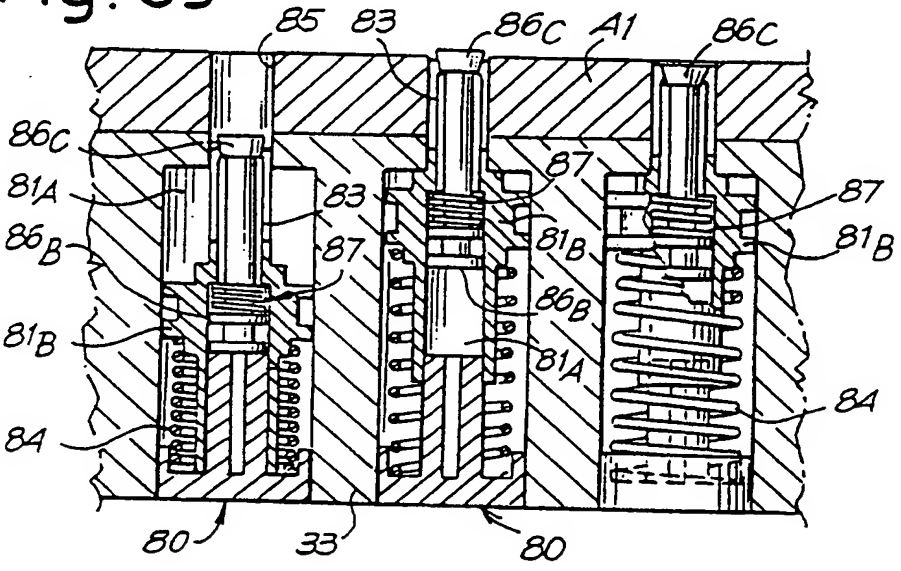

Fig. 60

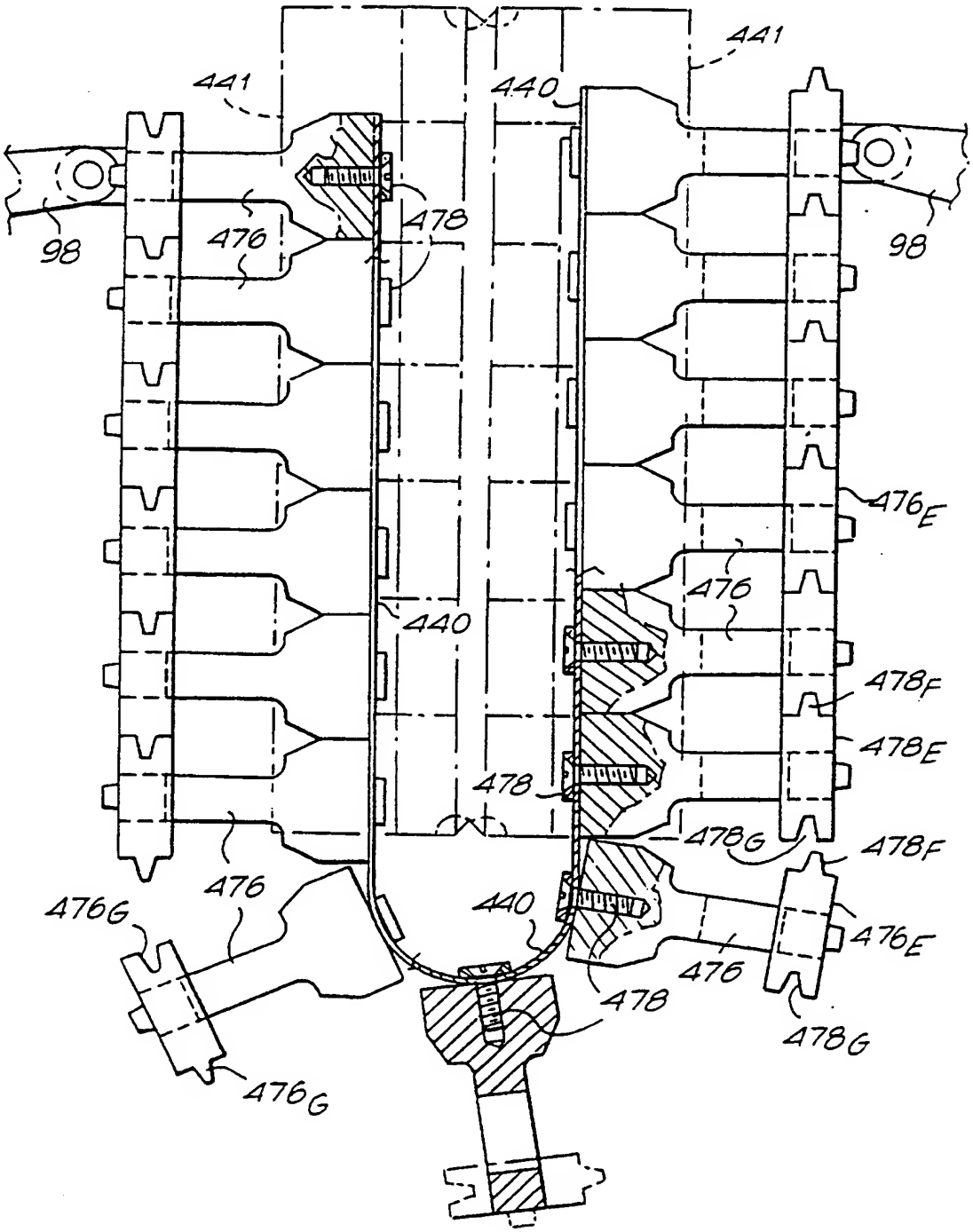
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Fig.61

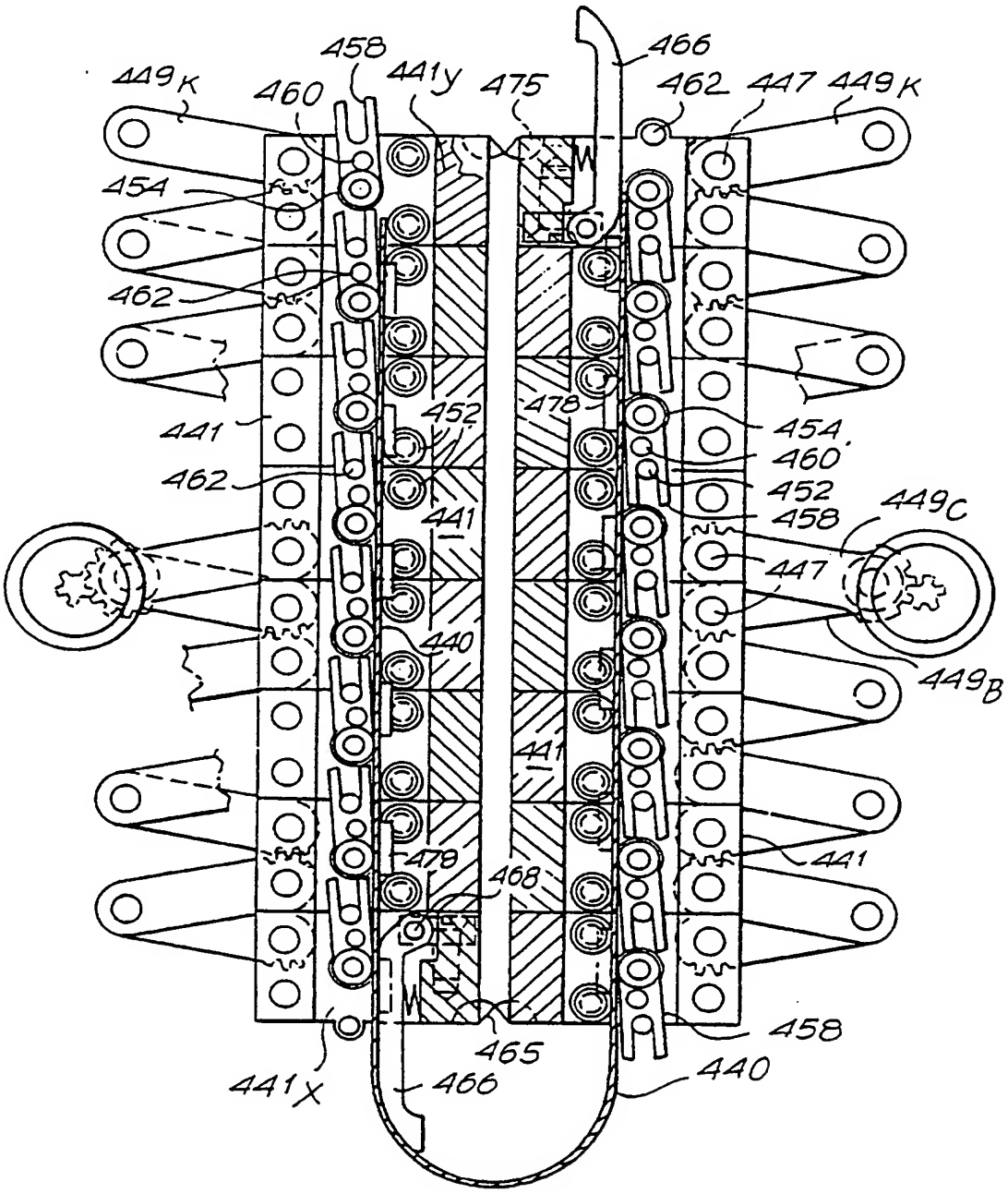
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Fig. 62

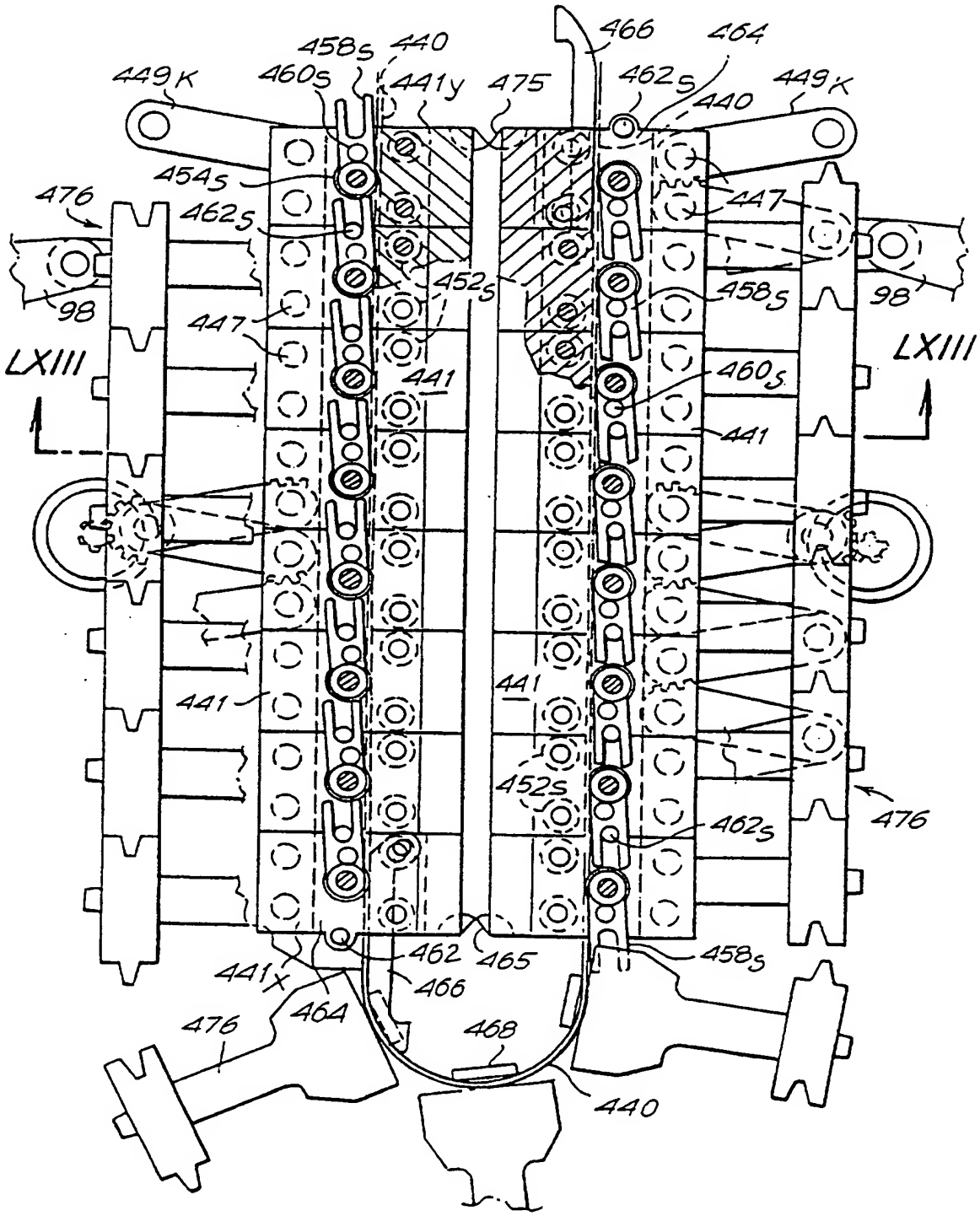
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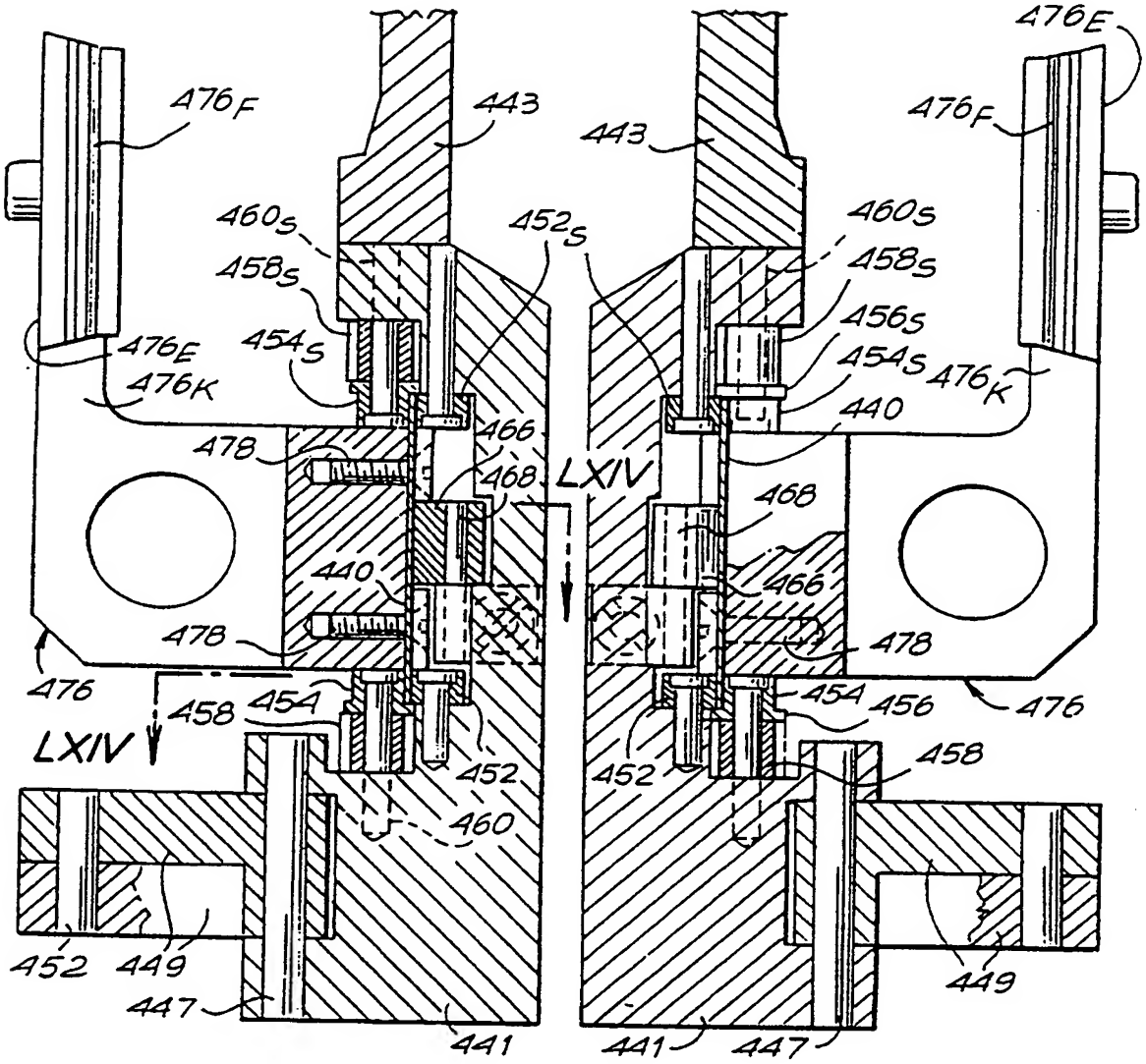
Fig.63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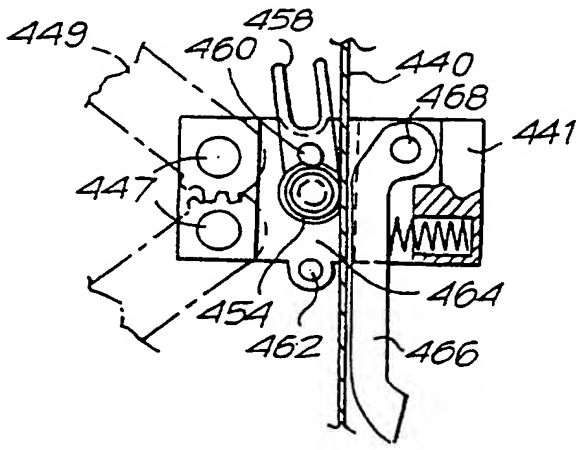
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Fig. 64

Fig.65

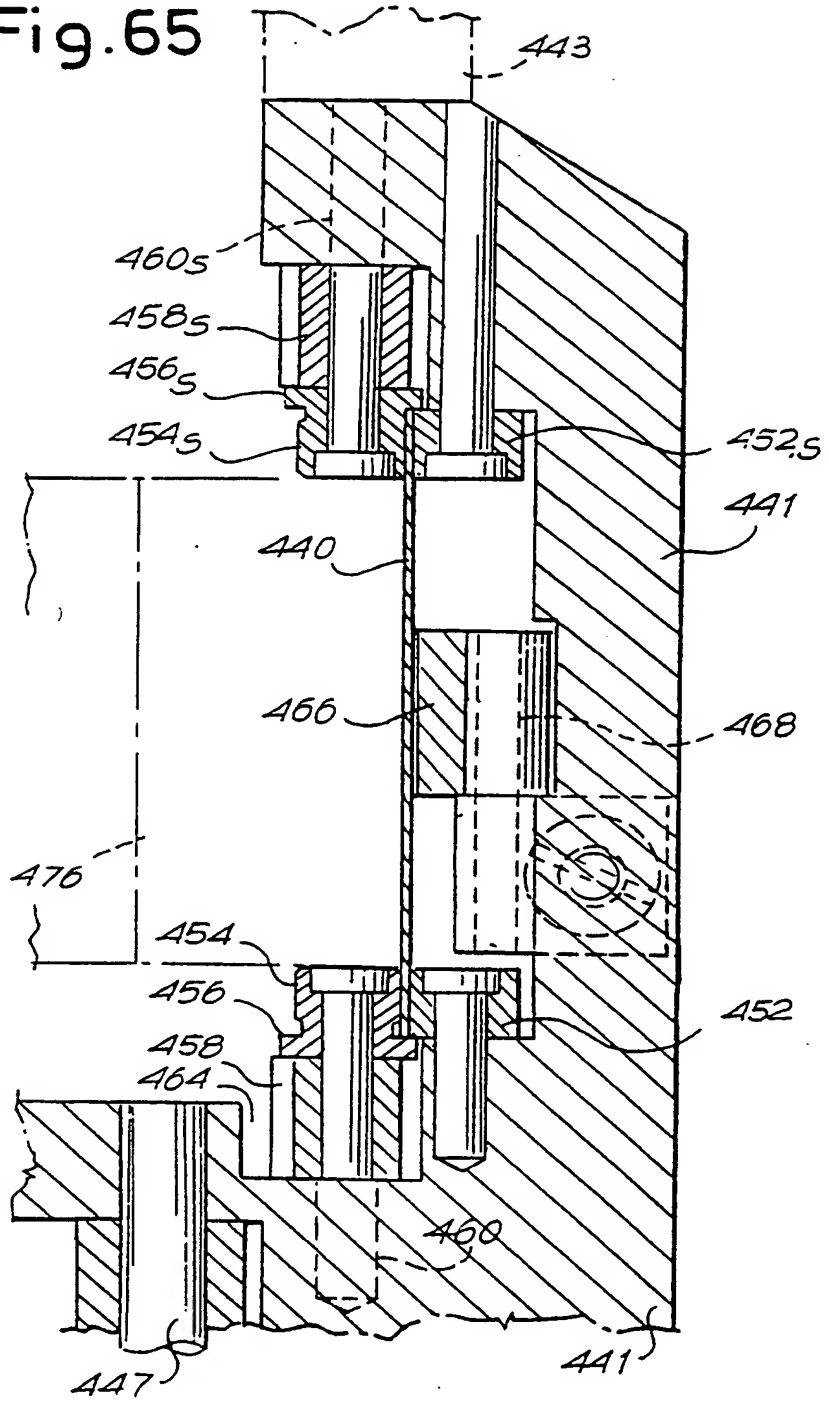
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Fig. 66

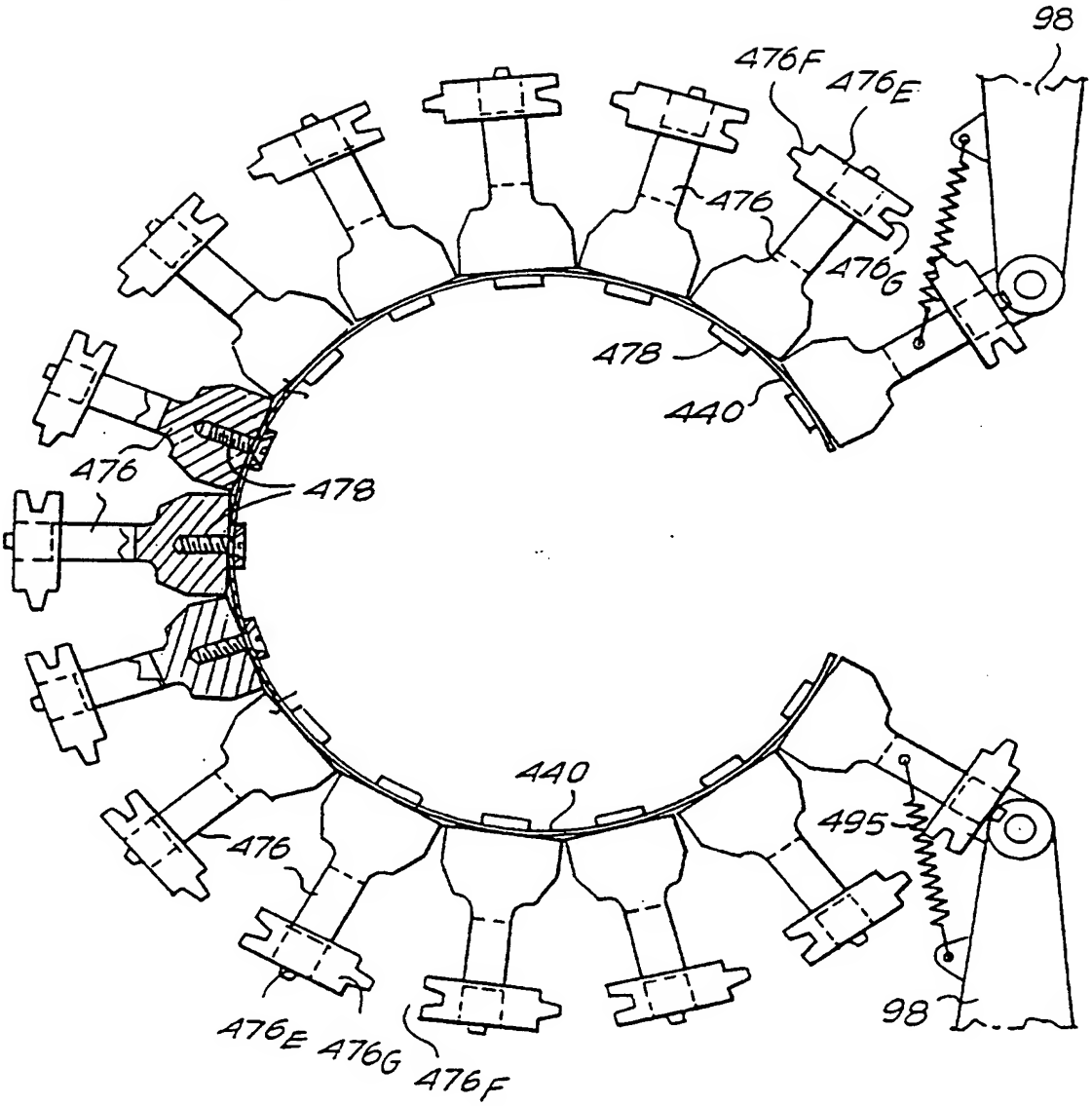
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Fig. 67

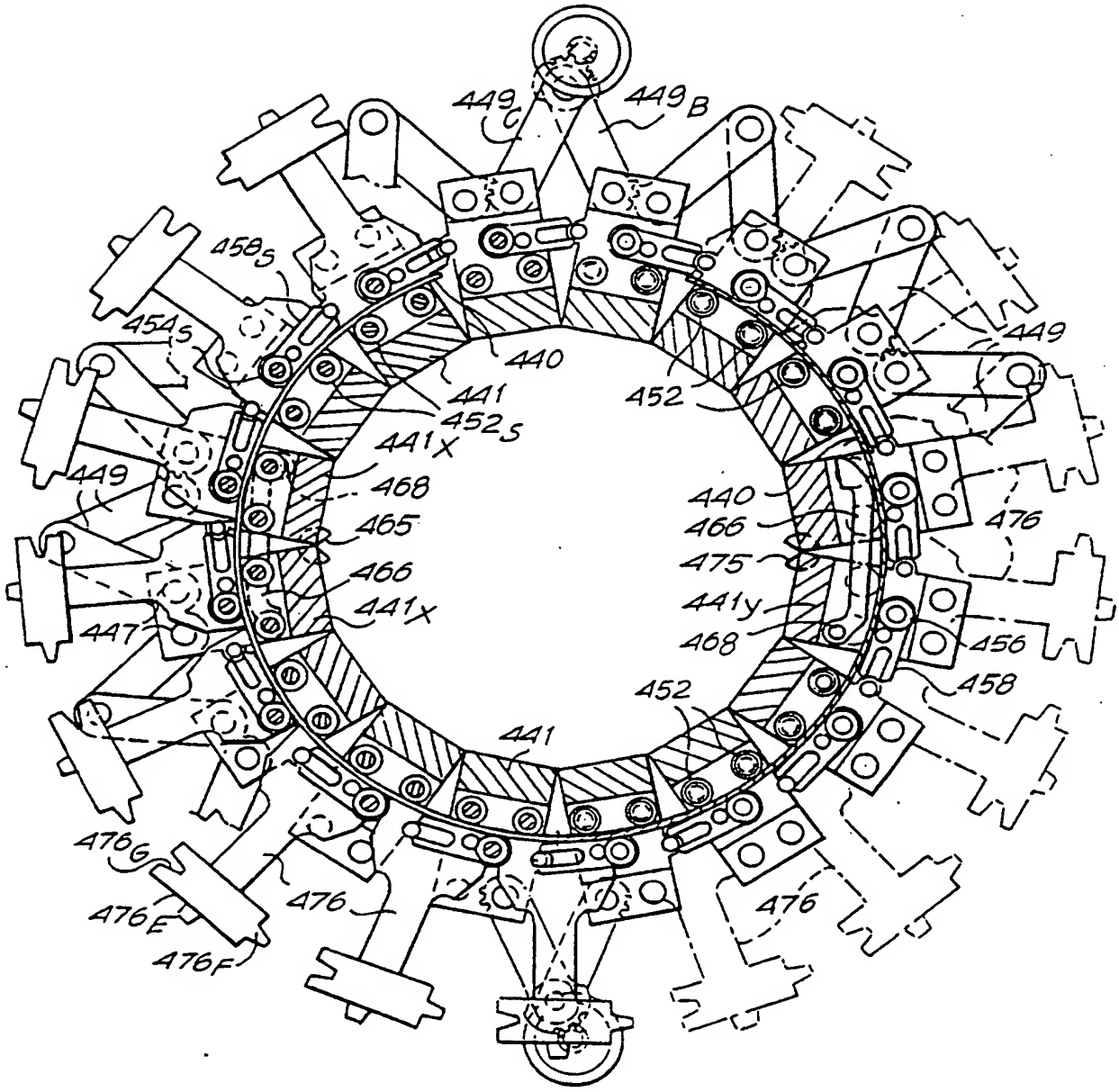
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Fig. 68

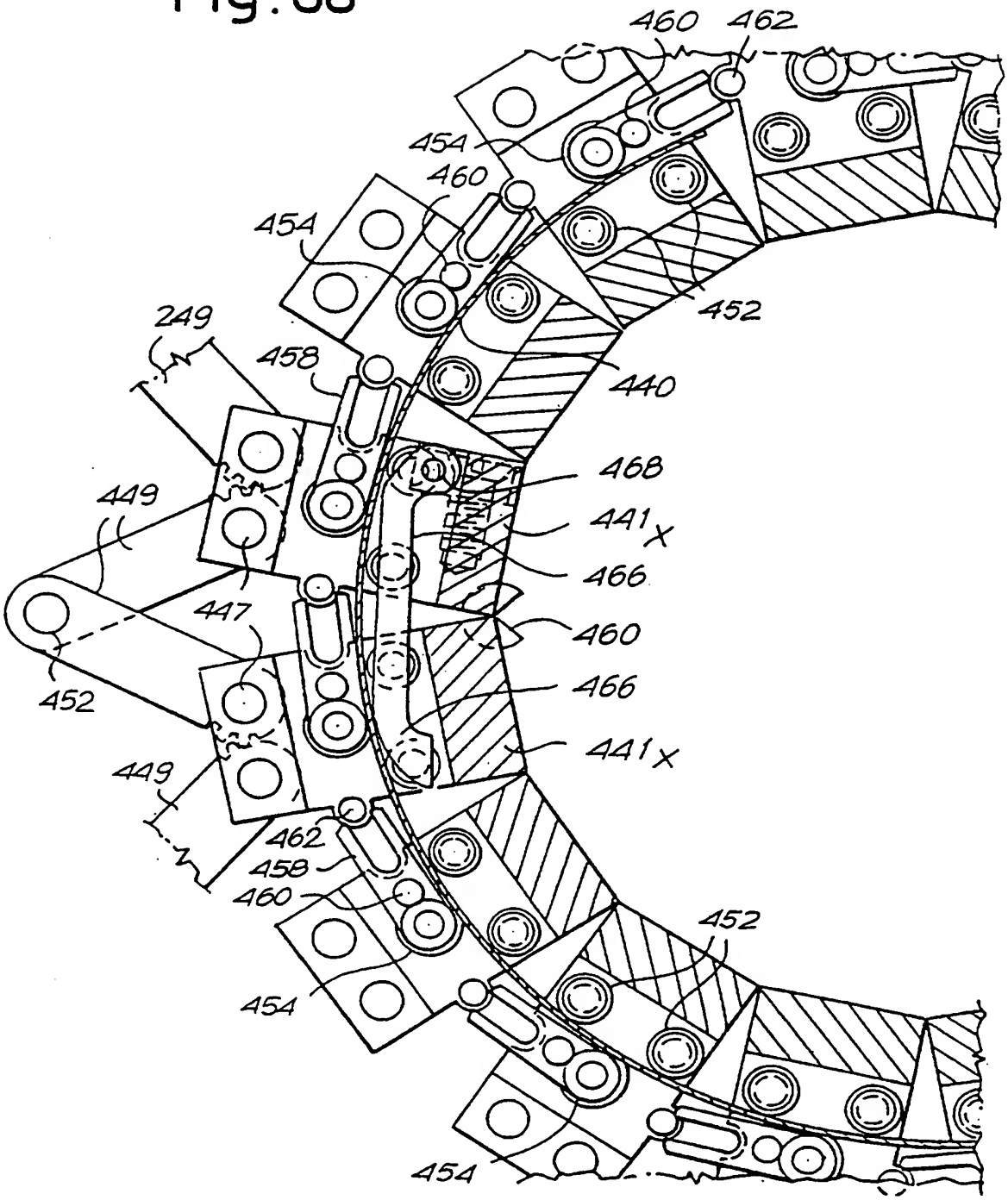
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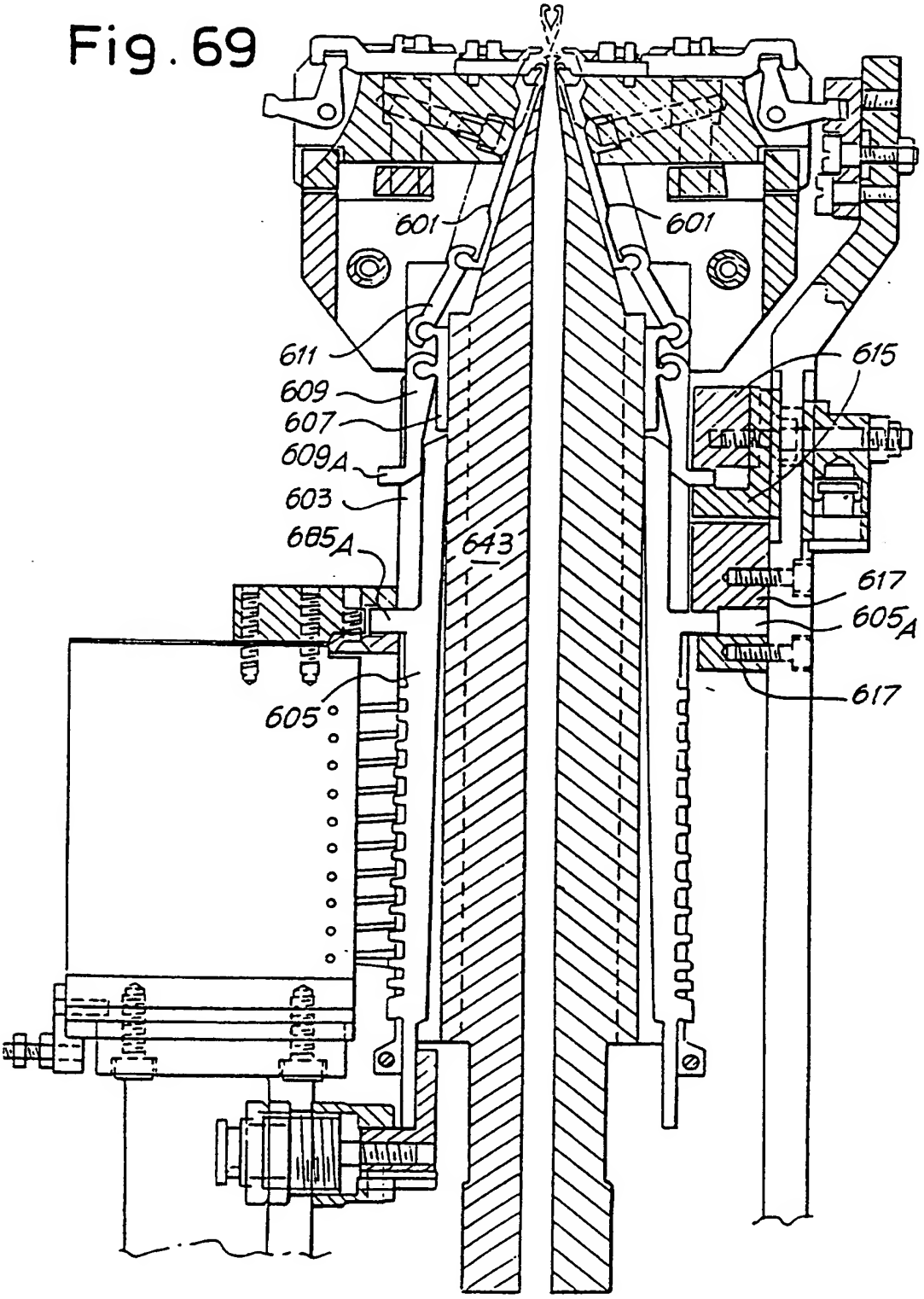
Fig. 69



International Application No
PCT/. . 94/00099

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D04B9/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	EP,A,0 552 588 (LAMBDA S.R.L.) 13 July 1993 cited in the application	
A	EP,A,0 412 944 (LAMBDA S.R.L.) 13 February 1991	
A	DE,B,11 38 883 (WEISSBACH) 31 October 1962	

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☒ Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 October 1994	27.10.94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Van Gelder, P

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International Application No
PCT/ 94/00099

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		JP-A-	3076852	02-04-91
		US-A-	5127240	07-07-92
DE-B-1138883		NONE		